THE

ELECTRICAL REVIEW.

VOL. XXX. JUNE 10, 1892. No. 759

CONTENTS:

	PAGE
Prof. Houston on Cerebral Radiation	719
A General Relation of E.M.F. to Equivalent Volume and Molecular Velocity of Substances	722
The Current that Kills	723
The Chemical Theory of Lead Accumulators (*illustrated*) ...	724
London Electric Railways	726
The Supply of Electricity at Bradford (*illustrated*)	730
Notes	739
Business Notices, &c....	742
City Notes, &c. :—	
Elmore's German and Austro-Hungarian Metal Company	743
Consolidated Telephone Construction and Maintenance Co.	744
Electric and General Investment Company	744
Western Counties and South Wales Telephone Company ...	745
Traffic Receipts	745
Share List of Electrical Companies	746
The Telephone at Home and in the Field	747
Parliamentary Notes	748
New Patents	749
Abstracts of Published Specifications	749
The Sensation from an Electric Shock	750
Correspondence :—Multiphase Motors	750
Notes on the Light of the Electric Arc	750
An Unfortunate Figaro	750

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1892,

Sent free within the Postal Union for 4s., net.

IMPORTANT.—The 1892 book contains 65 pages more than the 1891 edition; and, as nearly 100 pages of old matter which appeared in the 1891 book have been deleted or blended, the actual amount of new matter is over 150 pages.

It will be noticed that the 1892 book is not so thick as that of 1891, **although it contains 65 pages more**; this is owing to a much thinner but stronger paper being used, in order to reduce the cost of postage, which forms a very heavy item in our accounts.

H. ALABASTER, GATEHOUSE & CO., 22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGENRAY, LONDON." Code A B C. Telephone No. 517.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (*viâ* Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 3s, 10d.

BINDING.—Subscribers' numbers bound, including case, for 3s. 6d. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

PROF. HOUSTON ON CEREBRAL RADIATION.

WHEN we leave the phenomena of things materialistic and pass to those of mind, we enter a region profoundly mysterious. Science can be expected to do but little to aid us here, since the instrument of research is itself the object of investigation. It can but enlighten us as to the depth of our ignorance, and lead us to look to a higher aid for that which more nearly concerns our well being. Such was the gist of a passage in Prof. Stokes's address to the British Association at Exeter. Noble words, certainly, but not, it is to be hoped, calculated to discourage enquiry concerning what some people would have us call the Unattainable. If life be in any sense, however slight and restricted, physical, it is to that extent a fit and proper subject for the natural philosopher.

In exploring matters which lie upon the boundary of the attainable and the (at present) unattainable, it is admittedly difficult to avoid the Scylla and Charybdis of spiritualism and materialism. Yet, while there are men bold enough to venture, there is nothing to be gained by restraining them. The world has been rolling round for ages, yet it is only perhaps for about 300 years that the proper way of seeking for truth has been known. Since this was recognised, the achievements of physical science have increased million-fold; and it is not that we are now more able, nor that we have more leisure:

> for Romans now
> have thewes and limbs like to their ancestors.

It is rather, as Prof. Tait has said, that whenever the direction given to enquiry is a proper one, the men come forward. Such must not be discouraged, even if they should seem to be too daring.

Now and again we hear of wonderful discoveries "by accident;" such statements always incline us to be incredulous. It would be difficult to point to any discovery of any moment in physical science which has been the outcome of chance. Patient, intelligently directed labour, stimulated by imagination and supported by an unyielding determination in overcoming difficulties, are the factors which make for successful researches into the unknown. It is possible with a cultured and well-balanced imagination to recognise analogies which to the humdrum accumulator of facts might escape unnoticed. Men who have possessed such an imagination, and have used it aright, have advanced knowledge by leaps and bounds. Who shall say, then, that the scientist may not be speculative?

Prof. Edwin J. Houston has recently asked the members of the Electrical Section of the Franklin Institute, U.S.A., to consider what he calls "some rather wild speculations," in which he has endeavoured to correlate to some extent the phenomena of thought, with certain physical phenomena. On the assumption that cerebration, or thought, whatever

may be its exact mechanism, is accompanied by molecular or atomic vibrations of the gray or other matter of that part of the brain called the cerebrum, he proposes the following hypothesis to account for telepathy, mesmerism, thought transference, hypnotism, and other cognate phenomena.

Postulating the existence of the universal or luminiferous ether, which is now generally accepted in scientific circles, and bearing in mind the fact that this ether passes through even the densest matter, as easily as water through a sieve, it follows that the brain atoms, or molecules, that are here assumed as the cause of cerebration, are completely surrounded by the ether. Now since the ether is a highly elastic, easily movable medium, it would follow that thought or cerebration, if attended by vibration, must necessarily develop in the ether wave motions, which have the brain atoms or molecules for their centres. In other words, the act of thought or cerebration necessitates an expenditure of energy, because it necessitates the setting in motion of these assumed atomic or molecular brain particles.

That the brain cells can be caused to assume certain permanent groupings would appear to follow from the ease with which memory permits it to recall past peculiarities in the to-and-fro motions. How may these motions be produced? The answer would certainly appear to be from within and without. It is possible, perhaps, that the flow of blood to the brain which attends active cerebration affords the mechanical force that needs but to touch this marvellously attuned organ to awaken the thoughts already impressed upon it. Whatever the origin of these vibrations, energy is required to be expended in producing them. Energy thus expended in producing thought is dissipated by imparting wave motions to the surrounding ether, and such waves are sent out in all directions from the brain.

Facts are known which are far from being at variance with the assumption of the existence of the vibration of the brain particles. Prof. Houston assumes, then, that cerebral waves are given off from every active brain, and that these waves pass into the space around the brain, something like the waves that are imparted to the air around a sounding tuning fork. They are not so gross as those of sound; their wave lengths are almost certainly shorter; but they are imparted to the universal ether, and presumably partake either of the nature of transverse or torsional vibrations.

An active brain may be regarded as moulding the ether around it into thought waves that are spreading outwards from it in all directions; thus behaving not unlike a conductor, through which an oscillatory discharge is passing, and producing those waves which Hertz has so beautifully demonstrated as resembling the vibrations which produce light.

Prof. Houston explains the possibility of the transference of specific cerebral vibrations from an active brain to a passive or receptive brain, by the simple action of what is known in science as sympathetic vibration. He illustrates this by reference to the case of a vibrating tuning fork setting a second tuning fork, tuned in unison with it, into similar vibrations, by the sympathetic vibrations excited by waves of light in green leaves, and by the still more interesting case of electric resonance. In view of such facts, he says it does not seem improbable that a brain engaged in intense thought should act as the centre of cerebral radiations, nor that these radiations proceeding outwards in all directions should affect other brains on which they fall, provided that such brains are tuned to vibrate in unison with them. In such cases the absorption of energy by the recipient brain may be either a species of selective absorption, in which its train of thought is only modified, or it may be absolute, in which case the recipient brain has excited in it an exact reproduction of the thoughts of the exciting brain.

Prof. Houston suggests several ways in which it might be possible to test the truth of this hypothesis. But if these speculations be regarded as wild, what may not be said of the following:—If thought radiations partake of the nature of ether waves, then there should presumably exist in them phenomena corresponding to the various phenomena of thermal, luminous, electric, or magnetic radiation; even the phenomena of reflection, refraction, and possibly even of dispersion of such waves, would appear to be a possibility. If they partake of the nature of light, then it would seem among the remote possibilities of science to obtain a photographic impression of them on a suitably sensitised plate, somewhat after the manner of the ordinary photographic picture. Such a thought record, suitably employed, might be able to awaken at any subsequent time in the brain of a person submitting himself to its influences, thoughts identical to those recorded. That such a record may be obtained in the near future seems improbable, but a hundred years ago it would have been thought equally improbable that the telephone or the phonograph could have been produced; so this theory, bold though it undoubtedly is, necessarily merits serious attention.

Alternating Currents for Medical Purposes.

MM. G. GAUTIER and J. LARAT have succeeded in utilising for medical purposes alternating currents of high potential, furnished by the Usine Centrale d'Electricité des Halles, at Paris. The dynamos which produce these currents are of the "Ferranti-Patin" type; the alternations are 10,000 per minute, and the electromotive force 2,000 volts. Such high currents, it is superfluous to remark, are extremely dangerous, hence in order that they may be used for medical purposes they have to undergo a series of transformations. The primary current of 2,000 volts undergoes a first transformation which has the effect of conducting it to the apparatus under a pressure of 110 volts, when it ceases to be dangerous. By means of other transformers this current is reduced so as to make it suitable for being led into a bath, a douche-bath, an ozoniser, a cauterising apparatus, &c. Details of the installation are given in the *Comptes Rendus*, cxiv., p. 493. A remarkable influence on the economy has been noticed by MM. Gautier and Larat in the course of their investigations with these alternating currents, which appears to be due to two principal causes: (1.) A slow tetanisation (cramp) of the whole muscular system. (2.) A powerful reflex action on the ends of the motor nerves and also those of the sense nerves, extending even to the nerve centres. The effects of alternating currents employed in insulated baths upon the nutrition exchanges justifies the expectations that their employment may with care produce favourable modifications in certain affections or diathesic conditions, such as obesity, gout, rheumatism, and perhaps diabetes, &c., also in maladies caused by depression of the cerebro-spinal system. The experiments had been in regular progress some two and a half months before MM. Gautier and Larat felt justified in giving the preliminary results publication, and as they rightly observe, it is only by studying a vast number of cases and observing their con-

ditions over a sufficient lapse of time that it is possible to judge of the utility of a new method. They are busy studying the effect of the bath upon cutaneous affections. The application of the reduced current to cauterising purposes turned out to be highly successful, and excels in convenience as well as in effect other types of galvano-cautery. The transformer attached to this apparatus furnishes eight volts and from one to six ampères. A third transformer was employed in the production of ozone; it gives 1,000 volts with a current of 1½ ampères. The ozoniser is formed of plates of glass coated each on one face with metal foil, and separated from each other by a layer of air 2 mm. in thickness. An automatic "ventilator" worked by the current conveys the ozone away from the plates as required. Twenty patients suffering from anæmic, tuberculous emphysematic, and other diseases, have been under treatment for more than two months with ozone thus generated, but without appreciable result. MM. Gautier and Larat appear to be extremely doubtful of the beneficial effects of ozone. It seems to possess a certain toxicity, for it easily induces vertigo, bronchitis, sore throat, and allied affections; but it is possible that the ill-effects may be due to the nitrous fumes which are always mixed with ozone that is electrically produced from the air. The apparatus employed in these researches was installed by MM. Patin and Levavasseur, electrical engineers.

Mr. Pickering and the Dissociation Theory.

IN a recent issue of the *Berichte*, Mr. S. U. Pickering draws attention to certain objections raised by himself and others against the theory of electrolytic dissociation in aqueous solutions, and to the fact, as he states it, that his own researches all tend to prove the existence of hydrates in such solutions. He offers an explanation of the data on which the theory of electrolytic dissociation is chiefly based, taking the theory of residual chemical affinity as his starting point, in the hope that in this explanation, which also takes into consideration the existence of hydrates, there may be eventually found a ground for the reconciliation of the physical and chemical theories of solutions. Mr. Pickering's latest contribution to this subject is well worthy of careful study by the supporters of both sides of the controversy: all may learn something, and many will doubtless consider that the dissociationists will find difficulty in replying to the clear reasoning which the paper contains. Most of it, however, is of an order for which we can scarcely find room in these pages. But the paper should be read, and may be found in the *Berichte*, xxiv., pp. 3,629—3,647.

Wattmeter Corrections.

THIS question is again exercising the minds of readers of the *Electrical World*, and Mr. Danielson has a short communication showing how matters may be arranged so as to avoid the troublesome corrections of the well known formula necessitated by the presence of Foucault currents, hysteresis, capacity, &c. One of his suggestions is the time-honoured one of using a condenser to neutralise the self-induction E.M.F.; this, of course, labours under the slight defect of being true only at one frequency, but although the added capacity varies as the *square* of the period, this will not introduce much error in central station work, where the frequency, once decided on, is very fairly constant. The author does not seem to realise that in all probability, if his added resistance be of any size, the capacity effect of the latter will be even larger than he requires for correction. Probably the most satisfactory way of winding the pressure coils of wattmeters for alternating currents would be by utilising some of the methods proposed and patented by Mr. Mather and Dr. Sumpner. By the use of cylindrical conductors suitably arranged, or by flat wires, the effect of self induction could be quite got rid of, and in a more satisfactory way than by the use of an ordinary condenser.

Resistance Coils.

OUR contemporary *l'Electricien* gives an interesting resumé of the work done at the Charlottenburg laboratories on alloys for resistance coils. It is well known that the wire used for resistance coils undergoes a considerable increase in resistance during, and for some days subsequent to, the process of winding. On raising the temperature of such a coil, there is a further increase which increases progressively with the temperature, this is, of course, a permanent effect, and independent of the ordinary increase. The cause of this latter behaviour seems to be the presence of zinc in the German silver. An alloy of 25 per cent. nickel and 75 per cent. copper is exempt from the latter troublesome defect. It increases as usual in winding, but on heating to about 130° degrees for about five hours, the wire becomes annealed and returns to almost exactly its original resistance. There is no subsequent alteration as far as the experiments have gone. This alloy has the further advantage of a very low coefficient, ·0002 per degree C. Manganin is said to possess the same advantage as regards annealing properties, in addition to its well-known property of possessing a negative temperature coefficient of very small value.

Current Measurement.

THE shunt method of measuring large currents appears to be getting known better in America, and we have received a paper by Mr. C. W. Pike on the same. While traversing much ground that has been already well trodden, there are a few points of interest and importance referred to. Among this is the necessity for care in allowing for thermo-electric E.M.Fs. at the junctions of galvanometer wires. The author proposes to immerse the shunt in water or other liquid in order to keep the temperatures more constant. The danger of polarisation E.M.Fs. and leakage, even if the shunt were at first carefully varnished, would seem to militate against this proposal. There can be little doubt that the so-called "D'Arsonval method" of measuring large currents is very convenient, and susceptible of a very high degree of accuracy, if all proper precautions be taken against error; and it is probable that it will have a considerably larger sphere of usefulness in the immediate future.

Tempered Copper.

SOME samples of the so-called "tempered copper," made by the Eureka Tempered Copper Company, have been subjected to a searching examination at the Versuchsanstalt für Bau- und Maschinen, by Herr B. Kirsch, and we think that the conclusions which appear in a report in the *Mittheil. Techn. Gewerbe-Museums*, may not be without interest to electrical engineers, who are now, perhaps, as a whole, amongst the largest consumers of copper. In reviewing the results of the experiments performed in America and those which he carried out at the Versuchsanstalt, Herr Kirsch concludes that "tempered copper" possesses undoubtedly qualities or properties which distinguish it from the ordinary commercial metal. When tested in pieces of small cross-section its strength is remarkably high and this will at once command the attention of electrical engineers, especially, too, as we find that its electrical conductivity is stated to be high. It is curious, however, to note that test pieces of "tempered copper" of larger cross-section, show by no means a high degree of strength; its tensile strength in one instance, for example, was found to be only 19 kilos. per square mm. whilst a specimen of ordinary commercial copper of the same dimensions exhibited a tensile strength of 20—25 kilos. per square mm.

A GENERAL RELATION OF ELECTROMOTIVE FORCE TO EQUIVALENT VOLUME AND MOLECULAR-VELOCITY OF SUBSTANCES.

(*Continued from page* 694.)

THE experimental work under section B is classified by Dr. Gore in tables 16 to 35. In tables 16—23 of this section the kind of positive metal was varied, and that of the electrolyte was kept constant, the negative metal in the majority of the experiments being platinum. In tables 24—28 the effect of the dilution of the electrolyte at one metal only upon the *simple* amount of E.M.F. of the couple was studied; in tables 29—33 the effect upon the *mean* amount of E.M.F. of the couple was examined, and in the remaining tables of this section the influence of viscosity of the electrolyte was placed under investigation. The influence of viscosity was only partly examined, but it had no apparent effect.

The results in tables 16—23 show that the rates of change, *i.e.*, of increase or decrease of mean E.M.F. with different metals, by dilution of the same electrolyte, were very different, and that the increase was often less or the decrease greater with electro-positive metals giving larger E.M.Fs. than with those giving smaller ones.

The results in tables 24—28 show that the effect of dilution in diminishing the simple E.M.F. was greater at the positive plate than at the negative one; this was probably due to the greater energy of action at the former than at the latter. The dilution probably also affects the amount of simple E.M.F. to a small extent by altering the degree of electric conduction resistance of the liquid. In all the cases the simple E.M.F. was less with both metals in the weak solution than in the strong one.

The results in tables 29—33 indicate that dilution increased the mean amount of E.M.F. in each case by removing farther asunder, and increasing the freedom of motion of the molecules of the active dissolved substance, and that this effect occurred at each plate, and was the same in kind at the negative as at the positive one, but less in degree at the former than at the latter. They also show that when the freedom of motion of the molecules of the active dissolved substance is increased at the positive plate only, there is a "gain" of *mean* E.M.F. of the couple, but if at the negative one only, there is usually a "loss."

The whole of the results in sections A and B show that the amount of change of *mean* E.M.F. of the voltaic couple by dilution varied largely with the kind of positive metal, of negative metal, and of electrolyte; and the experiments on "the influence of dilution at one metal only," prove that the direction and amount of *mean* E.M.F. of the current is a result, not only of the action of the negative constituent of the liquid and the positive metal, but also of that of the same substance and the negative metal; that the latter action is the weakest; that the two actions are opposite and tend to neutralise each other, and that the final E.M.F. is the difference of the two. It is, therefore, largely a deficiency of electro-positive energy, which fits a conducting substance to act as the negative plate of a voltaic couple.

Neither a change of the kind of solvent nor a rise of temperature of the electrolyte prevented or appeared to diminish the gain of mean amount of E.M.F. on dilution.

SECTION C.—*Influence of Liquefaction of the Positive Metal with Different Metals and Electrolytes.*

It is well known the amalgamation of zinc is attended by a slight increase of the electro-positive condition of the zinc in dilute acids, notwithstanding that mercury is strongly negative to zinc in such liquids, and might, therefore, be expected to largely reduce the E.M.F. In this section Dr. Gore has examined this phenomenon and has ascertained the effects which amalgamation of different kinds of positive metals has upon this E.M.F.

The results are classified under tables 36—40. They show that liquefaction of the positive metal of a voltaic couple by means of mercury, increased its E.M.F., and indicate that this increase was due to greater freedom of motion of the molecules of the liquefied metal.

The results also indicate that an increase of freedom of motion of the molecules of the positive metal by means of solution in mercury, without any such increase of freedom of those of the electrolyte, is alone sufficient to increase the *mean* E.M.F. and energy of chemical union of that metal with the electro-negative ingredient of the electrolyte. This appears similar to the effects of mechanical collision of two solids, and supports the view that volta-electromotive force and its attendant energy of chemical union are due to mechanical impact of the two uniting substances.

The whole of the results of this section further show that the amount of change of *mean* E.M.F. varied with the kind of positive metal, of negative metal, and of the electrolyte.

SECTION D.—*Influence of Dilution of the Positive Amalgam, with Different Metals and Electrolytes.*

This section is discussed at some length and the results of the experiments are arranged in tables 41—47. The chief conclusions to be drawn are similar to those of Section C., and need not be repeated, and nearly all the remarks made on that section are applicable to this one.

SECTION E.—*Influence of Liquefaction and Dilution on the Negative Metal.*

The experimental results in this section take us up to the 57th table. They all confirm the conclusion that both liquefaction and dilution of the negative metal by enlarging the freedom of motion of its molecules, augments the chemical action of the liquid upon it and simultaneously increases its electro-positive, and decreases its electro-negative state, produces counter E.M.F. and consequently lessens the mean amount of direct E.M.F. and current.

SECTION F.—*Influence of Diluting one solid metal by means of another.*

In order to ascertain whether the dilution of a solid metal by another affected their mean amount of E.M.F., Dr. Gore made a series of alloys and measured their E.M.Fs., and that of their constituent metals with a negative plate of platinum in dilute hydrochloric acid.

A loss of mean E.M.F. indicates that the alloy is a chemical compound, a gain that probably no chemical union has taken place. The experiments are arranged in five tables according to the nature of the alloy studied; the results always indicated a change but sometimes these changes were losses, sometimes gains.

The general truth, that increase of volta-electromotive force and chemical energy of substances by dilution is due to increase of equivalent volume, is not limited to cases of liquefaction of metals, dilution of amalgams and electrolytes, and of solid metals by each other, but is of a much more fundamental and extensive character. In the 63rd table Dr. Gore has collected a number of examples which show that in a very large proportion of cases, though not manifestly in all, those elementary substances, both metals and metalloids, which exhibit the greatest E.M.F. and chemico-electric energy, are those which contain the smallest number of equivalent weights per volume; and the less energetic ones are those of small equivalent volume (other investigators have observed this circumstance). The equivalent volumes were obtained by dividing the equivalent weights by the specific gravities.

Dr. Gore shows that these calculated results are consistent with his experimental results.

As volta-electromotive force is thus related to the equivalent volumes of elementary substances, it is also necessarily connected with the atomic and molecular volumes and weights of those bodies; and as the specific heats of the elements are related to their atomic weights, and the latter are connected through the equivalent weights and volumes with their E.M.Fs., their specific heats must also be related to those forces; these relations also necessitate a connection between volta-electromotive force and the periodic law.

By reference to his tables of results Dr. Gore shows that the relation of change of mean E.M.F. by dilution to the atomic and molecular weights of the substances employed is less simple than to their volumes and molecular distances.

The relation of volta-electromotive force to heat was not experimentally examined. From the known data, however, it seems that the changes of E.M.F. are intimately connected with those of latent heat, and that every sudden change of such force and of molecular distance by dilution is probably attended by disturbance of the ether and by radiation of energy.

With regard to the influence of contraction of total volume during mixing, Dr. Gore states that the effects of such contraction were so small in comparison with those of the

enlargements of volume by dilution that they were not observed. Great chemical changes and alterations of internal structure of bodies often occur without much alteration of volume; alterations of total volume, therefore, afford much less information respecting the internal nature of the substances than the changes of mean E.M.F.

The much vexed question of the influence and presence of hydrates in solution is slightly touched upon by Dr. Gore. He found that the E.M.F. in the cases examined were not variable. Except in the case of the mixture $H_2SO_4 + H_2O$ when a slight diminution of gain of mean E.M.F. occurred, the results showed no signs of the ten hydrates of sulphuric acid existing as such whilst in solution; probably they begin to form only at temperatures approaching that of their separation in the solid state.

(To be continued.)

THE CURRENT THAT KILLS.

MUCH has been written on the subject of electric currents that are, or may be, dangerous, and many random statements have been made thereon, but nothing very definite has been arrived at. The problem involved in the question, "What current will kill?" is by no means a simple one, for several physiological complications have to be taken into account, which render it impossible to find the solution in the simple electrical laws which govern ordinary conductors.

The safety with which Mr. Tesla and others have lately been seen handling currents at many thousands of volts potential, is a matter of surprise to some; but a little reflection will show that such surprise is not based upon facts, but upon a misconception, due to the absurdity (far too common just now) of talking about a current of so many volts.

These high potential and rapidly alternating currents possess very little current strength; in fact, the quantity is infinitesimal, though the total energy is great. For instance, suppose that the initial energy put into one of Tesla's apparatus be 2 ampères at 4 volts, *i.e.*, 8 watts, and that this be so transformed by the apparatus that it comes out at 150,000 volts. Certain loss must take place in the transformation, say it is one-eighth, then the maximum energy obtainable from the secondary circuit is 7 watts. Of this 7 watts the volts number 150,000, so that the current strength can only be less than five hundred-thousandths of an ampère—a current which is too small to be worth a moment's consideration, and which the most delicate child could handle with impunity. It is true that these currents belong to the more dangerous form, *i.e.*, alternating; but it is also true that the rate of their alternation is so extremely rapid, that they no longer possess the possibilities for injurious effect upon the human body, which is so marked a feature of alternating currents at ordinary frequencies. This latter point is an important one, and was, we think, first remarked by Messrs. Lawrence and Harries, in their paper before the British Association in 1890, wherein, after enumerating experiments made with alternating currents at a frequency of 60 to 70, they stated that if the rate of alternation be diminished, the pain will be increased, *while if it be increased, the pain will be diminished*, so that the more rapid the alternations the more nearly did the conditions resemble those present with continuous current as regards sensation.

What we have to take into account is the quantity of current which passes, the time during which it passes, the part through which it is passed, and, in the case of alternating currents, the frequency of alternation. The controlling circumstances are the total resistance of the circuit of which the body forms a part, the size of the contact area, the condition of the skin, and last, but by no means least, the nervous constitution of the body.

Now, as to the quantity of current. First, with the continuous current we find from medical sources that very rarely is a current of more than 200 to 250 m.a. administered direct to the body, and then only for *destructive purposes*, the current being *carefully localised*, vital organs avoided, and the *patient placed* under *an anæsthetic*. There have been cases on record where the current has been run up to 500 m.a., but there seems to be great hesitation on the part of the profession to pass such a current even for the strictly localised destructive action referred to above. Mr. Perry and others have concluded that one ampère is always a fatal current, while another declares that one-tenth of an ampère is enough. In the face of the medical evidence of the amount actually used upon the body in treatment of disease we cannot accept the latter conclusion, while we think the other estimate too high. It is manifest that the fatal point lies somewhere close to the maximum allowed in medical work, for, of course, when desirous of reducing abnormal growths, such as tumours, &c., by means of the destructive action of electricity, the greatest current compatible with safety is used. Half an ampère, therefore, seems to us nearer the mark than an ampère, and probably represents the fatal point with sufficient closeness for the present. In stating this conclusion we do not, of course, mean that half an ampère would be fatal to everyone, nor, on the other hand, that a less quantity may not be fatal to some.

Individuality is as marked in such matters as in others, and this is what we meant by saying that one of the controlling circumstances in this question is the nervous condition of the subject. Experimenters have shown us that the ability to bear electric currents varies in different individuals, and it is only fair to conclude therefrom that such individuality may exist even up to the fatal point.

We cannot leave the matter here, however, or it might be supposed that we hold it unsafe for any conductors to carry more than half an ampère. There are other controlling circumstances which fortunately render it extremely difficult for any person to accidentally receive the fatal half ampère. These are the total resistance in the circuit of which the body forms a part and the contact area. The first resolves itself practically into the condition of the skin of the subject, and is intimately connected with the latter, inasmuch as the resistance of the skin varies (approximately, at least) in inverse proportion to the surface area of contact, provided, of course, that the degree of moisture be the same.

A few actual figures will help us here. Taking the resistance of the body from hand to hand when metal electrodes were grasped as found (when experimenting with dynamo currents) by Messrs. Lawrence and Harries at 6,185 ohms dry and 1,510 wet, the E.M.E. necessary to pass half an ampère would be 3,092 volts in the first case and 755 in the second. If, however, the contact area and moisture of the skin be large enough to reduce resistance to the minimum given by Dr. Waller, viz., 1,000 ohms, then 500 volts would pass the fatal current.

These voltages are practically never placed within reach of the public, even the lowest named being far in excess of the supply pressure allowed by the Board of Trade.

It appears to be further necessary that, in order to be fatal, the current must pass through the vital parts of the body, and arguing from the fact that transverse currents through the head are far more given to produce unpleasant results than longitudinal currents, it seems probable that transverse currents through the centre of the body would be more effective than those passed longitudinally. This conclusion we humbly submit to the consideration of the electrocution experts in America, who have, we believe, hitherto used longitudinal currents.

The time factor must not be lost sight of, though we hardly think it of the great importance some appear to consider it. Evidence on this point is hard to obtain, for in fatal accidents there has been no record, as far as we know, of the exact period of the contact at which life became extinct, while the reports of electrocutions speak mainly of a series of short contacts several times renewed. Supposing that the actual initial contact be not sufficient to destroy life, we cannot neglect the fact that even though half an ampère be all that passes at first, yet such a current would speedily break down much of the skin resistance, and be itself thereby increased to possibly many times its original value. It seems to us, therefore, that where the generator is of reasonable capacity, a very short time indeed of a current commencing at half an ampere would be required to produce the fatal effect.

With alternating currents at ordinary frequency (say, 50 to 100), it appears that the resistance of body is less, and its

power to bear the current without pain is also much diminished, so that when equal voltage is used, the point of pain is reached with about one-fifth to one-sixth of the current required of continuous current. We must therefore conclude that the fatal point for alternating currents at the named frequency is under, rather than over, one-tenth of an ampère, and that the voltage required to pass it will be 618 volts with skin dry, and 151 volts with skin wet. If, however, the frequency be increased, the difference between the two forms of current will be diminished, so that for very high frequencies it may well be that the figures given for continuous current hold good for alternating current.

The effect of initial shock is mainly a matter of nerves, for sudden unexpected contact with currents considerably less than the limits named above may be fatal to nervous and easily-frightened folk, while others would take such initial shock without serious results. There is, however, this important difference between the effects of the two forms of current. With even small alternating currents muscular fixation is produced immediately on contact, while no such effect has been found to accompany contact with the continuous current. The fright accompanying the former would therefore probably be much greater than that felt with the latter, though, of course, if insensibility be produced, the effect is much the same in both cases, for then in neither would the subject be able to release himself from continued contact.

THE CHEMICAL THEORY OF LEAD ACCUMULATORS.*

BY M. G. DARRIEUS.

I MUST, before entering upon my subject, ask your indulgence, as not being accustomed to speaking in public, it is particularly trying to me to speak before an audience of such eminent men as are assembled here to-day. I should, indeed, have shrunk from this task, which is perhaps beyond my ability, if I had not been stimulated by the encouragement of one of our most distinguished colleagues, who is esteemed and appreciated by all, and whose devoted friend I am proud to be; I mean M. Sarcia, whose share in the ideas that I am going to submit to you is considerable.

Among the various theories entertained with regard to the reactions which bring about the discharge of lead accumulators, the one most generally admitted is based on the hypothesis of the double sulphating of the two plates—positive and negative. This theory supposes that during the discharge the negative plate is the seat of a combination corresponding to the equation:

$$Pb + O + SO^3 = SO^4\,Pb, \qquad (1)$$

and that the positive plate itself undergoes a transformation represented by the equation:

$$Pb\,O^2 + H + SO^3 = Pb\,SO^4 + HO.$$

Electrolysis being a phenomenon arising from the orientation of the molecules, it is hardly probable that the same body, SO^3, for example, would act on the two electrodes at the same time.

Besides the fact that presented under this form the reactions seem incomplete and give a very confused interpretation of the phenomena, the mind can scarcely credit the formation of the same body at the two electrodes, which is contrary to the law of Faraday. I may mention, moreover, that the object of the different writers on this subject has been to make Thomson's law agree with the measurements observed. As the double sulphating gave the figures that approached the nearest to the theoretical calculations out of all the results observed, it was chosen for this purpose. The method followed in the present study, which is entirely based upon experiment and the results of analysis, has, on the contrary, aimed at drawing from the facts observed the most reasonable hypotheses without being biassed, *à priori*, by a law the application of which is always delicate, and especially so when we are dealing with hypotheses as to the reactions going on. Before studying the phenomenon of the discharge, which is of importance when considered as the production of electrical energy, we must first ascertain the nature of the different parts of the accumulator.

A knowledge of the nature of these parts at the commencement of the discharge will evidently be of great service in determining what this discharge is to be.

This accumulator consists:—

1. Of a positive electrode.
2. Of a negative electrode.
3. Of an electrolyte.

By studying the modifications undergone by these three parts during the process called *charging*, and their condition *before the discharge*, we can judge what phenomena will probably be produced during this discharge.

PHYSICAL AND CHEMICAL CONDITION OF THE ACCUMULATOR BEFORE THE DISCHARGE.

1. *Study of the Positive Plate.*—We will suppose that at the beginning of the charge the positive plate is simply lead; we know then by experiment what happens in accordance with the law of electrolysis. The lead is oxidised and acquires a very characteristic brown tint; it is useless, for the time, to try to ascertain the extent of this oxidisation. On interrupting the charge at the moment when, the tint being uniform, an abundant disengagement of gas is produced upon the plate, if we withdraw this plate from the accumulator to plunge it into a vessel full of pure water, the following phenomena are observed:—

A syrupy liquid flows from the bottom of the plate and is diluted in the water, whilst very fine bubbles of gas come to the surface and burst; this phenomenon is very easily observed by holding the vessel between the eye and the light.

On applying the method of analysis in order to learn the nature of the syrupy liquid and of the gas given off, it is easily discovered that we have to do with sulphuric acid and oxygen. Thus we have reason to think that the liquid on the positive plate contained an unstable hyper-oxygenated body that decomposes in pure water.

On taking a sample of the liquid of the accumulator and treating it with iodide of potassium, with the addition of starch, a decomposition is produced which liberates the iodine colouring the starch blue.

This first point being arrived at, what is the hyper-oxygenated body? On referring to M. Berthelot's researches on the electrolysis of diluted solutions of sulphuric acid between platinum electrodes, we find that three different bodies may be produced, giving rise to almost the same reactions, persulphuric acid, oxygenated water, and ozone. We have, therefore, to distinguish between these; we have found that the action on iodide of potassium is the same for all three bodies.

On treating this same liquid that drips from the positive plate with chromic acid, no blue colouration is produced; we can, therefore, reject the hypothesis of oxygenated water, the action of which on chromic acid, which it transforms into perchromic acid, is most powerful, even when in a very weak solution.

Then, as we know the exact quantity of permanganate of potassium, necessary to oxidise a known weight of arsenious acid, if we make the liquid taken from round about the positive plate act upon this arsenious acid, we find that, before and after the operation, the quantity of permanganate necessary to transform into arsenious acid is exactly the same. The liquid of the accumulator, therefore, has no effect upon arsenious acid, so that it does not contain ozone, and thus we may conclude that persulphuric acid ($S^2\,O^1$) is present, taking care, however, to filter the liquids each time, and to make sure that they do not contain leaden compounds, for peroxide of lead also decomposes iodide of potassium. These precautions being taken, it will be possible to use this last body as a reacting agent on persulphuric acid.

By performing this analysis at different periods of the charge, we observe the following facts:—

The persulphuric acid appears in the liquid in which the positive plate is immersed from the first moments of the charging, and the reaction which shows it is clearer in proportion as the concentration of the liquid into sulphuric acid is stronger; with a liquid acidulated to 5° B., it is scarcely visible.

First Experiment.—Three positive plates over-charged have been placed in a vessel containing 5 litres of distilled water,

* From the *Bulletin de la Société Internationale des Electriciens*, read May 4th, 1892.

and the acidity of the liquid estimated to have been converted into sulphuric acid is taken at different moments ; the acidity increased progressively up to 14·490 grammes of sulphuric acid per litre. The liquid being put aside and replaced by distilled water, we again obtained about 2·625 grammes of sulphuric acid per litre, which gave a total of 17·115 grammes per litre, or, for the 5 litres, 85·575 grammes of sulphuric acid, corresponding to three plates out of an accumulator of seven plates weighing together 17·500 kilogrammes.

On making a rough calculation of the corresponding weight of free oxygen, we get about 7 grammes of free oxygen, which is equivalent to 1·3 ampère hours per kilogramme. We shall see later on the importance of this quantity, which is a rough maximum far above the exact figures, unless an error has been committed in the estimation of the total amount of acid, into which that simply disgorged by the plates which it impregnates, largely enters.

Second Experiment.—Taking the positive plate again, and endeavouring to measure the gaseous volume obtained by the decomposition of the persulphuric acid, we proceed as follows :—

A determined weight of charged positive material is plunged into a flask exactly filled with a known volume of water ; this flask is closed with an India-rubber stopper through which passes a capillary tube (fig. 1). The stopper

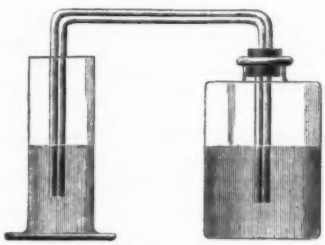


FIG. 1.

being sunk, the tube is exactly filled, so that by the water which flows out we get a measurement of the volume of gas given off. The water used had, moreover, been freed from gas by being boiled previously.

The volume of oxygen obtained in this way was about 1·1 cubic centimetres ; on raising the temperature to 100°, the quantity of oxygen was increased by 1 cc. ; this amount of oxygen corresponds to ·15 of an ampère hour per kilogramme of plates. We will assume, for the moment, only, that this quantity corresponds to a *minimum* due to errors in the method and to the difficulty in getting rid of the whole of the gas.

If we charge an accumulator and leave it at rest for several days, the positives draining meanwhile, the liquid filtering from them shows the presence of persulphuric acid, but the reaction becomes weaker and weaker, and disappears after a lapse of time, which depends on the charge being more or less complete.

Up to now we have not entered into the nature of the positive active material ; the only point known is, that it evidently contains an oxide of lead. We must now find out the degree of this oxidation.

On treating with nitric acid, the brown matter obtained after the charge from the positive plate, we find no soluble compound ; we may therefore say that there is certainly no oxide below $Pb\,O^2$. This result indicates the method to be followed, which will consist of treating this active material with hydrochloric acid ; any oxide above Pb O and in the form $Pb\,O^n$, on being treated with hydrochloric acid, gives rise to a liberation of chlorine in accordance with the equation

$$Pb\,O^n + n\,H\,Cl = Pb\,Cl + n\,H\,O + (n-1)\,Cl\,;$$

from the quantity of chlorine given off we deduce the unknown coefficient, n.

To eliminate all causes of error, and granted that we wish to obtain comparative results only, it seems the most simple method to proceed by analyses of known weights of charged active positive material ; the comparison of the weights of chlorine found will be sufficient for the conclusions required. The chlorine given off was collected in the iodide of potassium, and the iodine liberated treated with hyposulphite of soda.

The positive active material when charged contains persulphuric acid, which is a hyper-oxygenated body ; treated thus with hydrochloric acid it should evidently furnish a value for Cl above that which actually corresponds to the coefficient of oxidation of the lead. Before the treatment with hydrochloric acid, therefore, all traces of persulphuric acid must be eliminated ; to do this it is sufficient to dry the positive active material by heating it to 110°, after having washed it in pure water, or it may be washed in alcohol and dried in a vacuum ; we find, after this operation, that the liquid that drains away no longer acts on the iodide of potassium, or if we do not take this precaution the water and sulphuric acid contained in the sample must be measured in order to deduce from them the proportion of $Pb\,O^n$.

Three successive experiments made with one or other of these methods gave per gramme of active material weights of chlorine respectively equal to

·31, ·315, ·305, of a gramme.

A fourth, made upon a sample not dried, but only washed, gave ·308 of a gramme.

A fifth, made upon a sample, neither dried nor washed, treated with hydrochloric acid, immediately after being taken out gave ·302 of a gramme, all these results corresponding pretty closely. Now, 1 gr. of $Pb.O^2$ should give theoretically ·301 of a gramme of Cl, which value approximates closely to those given above : we may moreover observe that the error committed by this method is *in excess*, and that, consequently the quantities obtained are too high, for the hydrochloric acid distilled at the same time as the Cl liberates the iodine ; we may also remark that the active matter when insufficiently dried gives off on being crushed a strong odour of ozone, probably due to the decomposition of the persulphuric acid ; this ozone also produces a value above that produced by the chlorine. We might already conclude that the oxide forming the positive plate is not above $Pb\,O^2$; to prove it we have merely to proceed by synthesis, constructing a positive plate with peroxide obtained by chemical means. This is done by treating chloride of lead with a hot concentrated solution of Javel water ; a positive plate thus constructed gives with the ordinary charged negatives an electromotive force of 1·88 volts.

Now, an ordinary positive plate charged after having been carefully washed and heated, in order to remove the traces of persulphuric acid which it contains, gives with the charged negatives, an electromotive force of 1·92 volts ; the approximation of the two values is suggestive ; the same experiment repeated with zinc negatives gave in both cases the same electromotive force, 2·36 volts, taking care to agglomerate well the peroxide of lead obtained by chemical means, so as to get good conductivity. A sample of positive active material taken out after being charged in potash or caustic soda gives a colloidal product which precipitates peroxide of lead in nitric acid. The identity seems now established between $Pb\,O^2$ and the positive material after charge, and we may admit that the plate contains a fine charge of peroxide of lead impregnated with persulphuric acid.

2. *The Liquid.*—The liquid in lead accumulators is water acidulated with sulphuric acid of variable density ; from the commencement of the charging, on taking samples of liquid from different parts of the mass, we find that this liquid gives the reaction of persulphuric acid ; this reaction, I repeat, is more easily seen in proportion as the density of the liquid is greater. This is explained by what we know of the properties of persulphuric acid, and its instability in very much diluted acid, which instability is clearly shown by exposing a positive plate in pure water.

In a charged accumulator at rest, the presence of the persulphuric acid is betrayed throughout the mass of liquid, round the negatives as well as the positives, but it disappears very rapidly.

The liquid taken from round the positives always contains very small quantities of persulphuric acid (0·1 of a gramme per litre) ; round the negatives the quantities are too small to be measured.

Finally, we may remark, without yet explaining it, that the density of the liquid increases during the charge.

3. *Study of the Negative Plate.*—We will again suppose the electrode to have been a plate of lead at the beginning of the first charge ; on stopping the charge when the free libe-

ration of the gases shows the end of the operation, we will take samples of the negative active material, in order to subject it to analysis. Two hypotheses may guide us in the choice of the method to be employed; either we have to do with lead only, or this lead being in a very divided state, retains in its mass hydrogen arising from the electrolysis, either in suspension, or in the form of a hydruret, in accordance with the analogous well-known properties of palladium, antimony, copper, &c. It does not seem possible to assume any other hypotheses than these two. Moreover, the negative active material, on being treated with nitric acid, in which it is wholly soluble, shows clearly that there is only lead.

The most effectual method of ascertaining its nature is to treat a known weight of negative active material with hydrochloric acid. The hydrogen collected will serve as a measure, for if the active material is formed of lead only, the hydrogen collected will be given by the formula:

$$Pb + H\,Cl = Pb\,Cl + H.$$

If it is a hydruret, we shall, on the contrary, have the equation

$$Pb\,H + H\,Cl = Pb\,Cl + 2\,H,$$

or, in the second case, a weight of hydrogen double that in the first.

A first experiment was made with an apparatus identical with that shown in fig. 1. The negative material of a known weight was introduced into the vessel filled to the brim with hydrochloric acid.

The volume of water that flowed from it served to measure that of the hydrogen given off.

We thus collected 330 cc. of hydrogen, corresponding to 2·615 grammes of lead measured in the whole of the liquid. Now the theoretical quantity of lead necessary to produce 330 cc. of hydrogen is 2·987 grammes, a quantity corresponding fairly well with the above, if we take into account possible errors committed in the experiment.

To get exact mean values, a number of comparative experiments on samples of charged negative active material and of lead finely divided, have been made, and are summarised in the following Table:—

MEASUREMENT OF THE VOLUME OF HYDROGEN OBTAINED ON TREATING THE LEAD AND THE NEGATIVE ACTIVE MATERIAL WITH HYDROCHLORIC ACID.

		Weight of material treated.	Volume of hydrogen obtained.	Temperature.	Barometric pressure.	Volume of hydrogen brought to 0° and 760 mm.	Volume of hydrogen at 0° and 760 mm. for 1 gramme of material.
		gr.	cc.	deg.	mm.	cc.	cc.
I.	Ordinary lead	1·5	186	20	754	172	114·6
	Charged "	1·102	134	"	"	123·8	112·3
II.	Ordinary "	1·5	186	20	750	171	114
	Charged "	1·445	176	"	"	161·9	112
III.	Ordinary "	30	3,780	21	763	3,477	115·9
	Charged "	23·6	2,950	"	"	2,714	115
IV.	Ordinary "	30	3,750	20	763	3,450	115
	Charged "	26·85	3,340	"	"	3,071·6	114·4

MEAN OF THE EXPERIMENTS.

Ordinary lead	114·9
Charged "	113·4

The lower value for the charged lead arises, in point of fact, from the difficulty in obtaining complete charges. The volumes of hydrogen brought out for 1 gramme of active material agree pretty closely, especially in the two last experiments, in which the relative error committed, which cannot be avoided with this method, has been reduced by operating on a larger quantity of material, so that we may conclude that the charged negative material is nothing but lead. A sample of this same material, on being calcined in a porcelain crucible, melts just like ordinary lead.

On being treated with diluted nitric acid it gives off bioxide of nitrogen and hyponitrous acid, without any trace of hydrogen gas, just like ordinary lead finely divided, on which, however, we must add, the action is slower.

If the negative material after charging consisted of a hydruret, on amalgamating this material we ought to find hydrogen given off; now in an experiment of this kind we find an absolutely insignificant volume of gas.

A sample charged, taken from under the water and reduced to small fragments, was also introduced under the water in a phial; the mercury was poured into the bottom of the phial, which was immediately closed hermetically. No liberation of gas was produced during the operation. The volume of hydrogen was always measured by the volume of water flowing through a capillary tube. Shaking it favours amalgamation, which is very rapid, being almost completed in half-an-hour. Now 12 grammes of material which should have produced more than 100 cc. of hydrogen only gave an insignificant volume below 1 cc.

A second experiment was made upon a sample of 28 grammes of material; the amalgamation lasted eight days, and only furnished 12 cc. of hydrogen, when, theoretically, we ought to have had more than 400 per ampère-hour. The identity of the charged active negative matter with lead seems now completely established, and, to sum up, the charged accumulator consists of a positive electrode of peroxide of lead, $Pb\,O^2$, impregnated with persulphuric acid, and of an electrode of lead containing at the beginning some traces of free hydrogen in a liquid containing sulphuric acid and giving the feeble reaction of persulphuric acid. In accordance with the method of investigation adopted and before any hypothesis or interpretation, we must try to find in the same way by different methods what is the nature of the different parts of the accumulator after discharge.

(To be continued.)

LONDON ELECTRIC RAILWAYS.

WATERLOO AND BAKER STREET LINE.

THE various Bills proposing electric underground railways having been referred by the Committee of Selection to a Committee of the House of Commons, consisting of Sir John Kennaway, Bart. (chairman), Mr. T. W. Sidebotham, Mr. E. Holden, and Mr. Esslemont, the committee held its first sitting last Tuesday week, Sir John Kennaway presiding. The first railway dealt with was the Baker Street and Waterloo Station Railway. The counsel for the Bill were Mr. Pember, Q.C., Mr. Cripps, Q.C., and Mr. Francis, and the opponents to the Bill were represented as follows:—The trustees of the Constitutional Club, Mr. A. G. Rickards; the National Liberal Club Buildings Company, Mr. Erskine Pollock; Mr. D. N. Howell by Mr. Dale Hart; the St. Martin's Vestry by Mr. Mersey Thompson, Q.C.; the Conservators of the River Thames by Mr. Littler, Q.C., and Mr. Claude Baggally; the South Eastern Railway Company by Mr. Littler, Q.C.; Mr. Worsley Taylor, Q.C., and Mr. Tufton; the Gordon Hotels Company, Limited, by Mr. Pope, Q.C., and Mr. Freeman; the Metropolitan Railway Company by Mr. Littler, Q.C., and Mr. Worsley Taylor, Q.C.; and the London County Council by Mr. Freeman. Petitions against the Bill were also presented by the Lambeth Vestry, the Metropolitan District Railway Company, the Union Bank of London, the Sun Insurance Company, the Hotel Victoria, the County Fire Office, and the Vestry of St. Marylebone, who reserved the appearance of counsel.

Mr. PEMBER, Q.C., in opening the case for the Bill, stated that his clients proposed to construct a railway starting at Baker Street and going to Waterloo. The length of the proposed line was 2 miles 7 furlongs and a few chains, and the capital was to be £2,500,000, with borrowing powers to the extent of £416,000, the estimated cost of constructing the line being £990,000. The railway was to be constructed with two separate tunnels for up and down traffic. It would be worked on the electrical system which had now become famous, and which Mr. Greathead and Mr. Galbraith, the engineers, would explain to the committee. The fares were to be 2d. a mile first class, 1d. a mile second, and then there was the question of workmen's trains. The company would be compelled to run at least one train each way to call at every station each way morning and evening every weekday, to start not later than 7 or earlier than 6 in the morning, the total fare not to exceed one penny each journey. They proposed to have five stations at the following places:—Waterloo, Charing Cross, Piccadilly Circus, Oxford Street Circus, and Baker Street. Mr. Pember then reminded the committee that there had been a preliminary examination of all the schemes by a joint committee, who had issued a report favourable thereto, and he asked for a decision as to whether it would be necessary for him to call evidence proving the utility of the railway, or whether he might not take it that on that score Parliament had given the schemes their sanction.

The CHAIRMAN said he would reserve his decision until he had seen a list of parties opposing the railway.

Mr. PEMBER then criticised at some length the various petitions against the Bill.

The CHAIRMAN, after consultation with his colleagues, said the committee were satisfied as to the general utility of the proposed railway, and therefore they would not wish any evidence on that

point, as it was clearly proved that the traffic was overgrown, and that it was desirable to relieve the crowded streets and open communication between the north and south of London.

Mr. LITTLER, Q.C., said that some of the petitions raised the question as to the value of electricity as a motive power.

The CHAIRMAN: Then I think it would be as well to have some evidence shortly on that point.

Mr. LITTLER: That will be mainly a question of cost.

The CHAIRMAN: It would be very easy to put some representative of the existing electric railway in the box to give evidence on that point. It could be done very shortly.

Mr. PEMBER: Yes. I will put Mr. Greathead in the box, who will give the committee all the information on that point.

Mr. GREATHEAD was then called, and examined by Mr. Francis said he was joint engineer of the proposed railway with Mr. Galbraith. Having detailed the route the line proposed to take he said that the speed of the trains would be about three times that of the omnibuses. The proposed station at Waterloo would occupy some of the arches which run across the whole of the existing Waterloo station. The sharpest curves on the proposed railway would have a radius of 4 chains, and the steepest gradient would be 1 in 55. The City and South London Railway, which had been in full work for some time, had curves of a radius of 4½ chains, and its steepest gradient was 1 in 30. As to the depth of the line below the surface, the witness stated that at Baker Street it would be 48 feet below the surface, and 22 feet 3 inches below the rails of the Metropolitan and St. John's Wood Railway. At Allsop Place the depth would be 48 feet, and at Marylebone Road 66 feet.

The CHAIRMAN: What is the depth under Regent's Park.

The WITNESS: 53 to 66 feet. In the outer circle it would be 68 feet, and at Park Crescent 70 feet. The depth then increased until Oxford Street was reached, when the railway was 85 feet below the surface. In Regent Street it was from 77 to 81 feet, and then it gradually diminished as the surface of the ground fell, till they got to the Haymarket, where the depth was 56 feet; at Charing Cross it was 52 feet, and in Northumberland Avenue from 53 to 58 feet. It would go 34 feet below the rails of the Metropolitan Railway, which would be 54 feet below the surface. Under the Thames Embankment the railway would be 52 feet below the surface, and on the south side of the Thames the depth was from 46 feet, diminishing down to 15 feet at the end of the railway.

Mr. LITTLER, Q.C.: What is the depth under the bed of the Thames?

The WITNESS: 16 feet from the bed of the river. Continuing, he said that the deviation clause would allow them to go as much deeper as they liked; but there were limits as to the height they were to be allowed to raise the line. On the north side of the Thames the line would be generally in the London clay, but on the south side it would pass out of that soil into a stratum of gravel and sand. It would be desirable, if possible, to place the whole of the line in the London clay, because it could be constructed cheaper on that stratum than in any other; but there would be no difficulty whatever in the construction of the tunnel, whether in clay, sand, or any other strata. At the present moment tunnels were being driven through sand, and in constructing the City and South London line, they had to drive through water bearing strata, and it was done without the slightest difficulty. He then described at length the mode of boring and constructing the tunnel. With reference to the City and South London Railway, that had been in full working order for about 18 months, and it was taking nearly 350 trains a day, and although, of course, there had been some light hitches and delays, the traffic had been conducted in such a way as to compare favourably with other suburban railway traffic—especially during the foggy weather. On foggy days, when the ordinary railways had the very greatest difficulty in conducting the traffic, they did so with perfect ease, there being no fog whatever in their line or stations. As to the uses of electricity as a motive power, there could be no question as to its utility on that point, and for many years it had been largely used in America and other places for that purpose. The total estimated cost of constructing the tunnels and line was £990,000, and to that must be added another £300,000 for hydraulic lifts, electric plant, rolling stock, &c.

Mr. LITTLER then cross-examined the witness, who said that he did not think the Metropolitan and St. John's Wood Railway would be at all affected by the proposed line if, at any future time, they wished to widen their station at Baker Street. As to the traffic on the proposed line, he estimated that it would exceed that of the City and South London line, as they would expect to get their trains fairly well filled throughout the whole of the day. On the City and South London line they ran trains about every 4½ minutes, and they were always full. They could run them every 2½ minutes, only they had not sufficient rolling stock. If they had more trains the profits would be much greater, because in running an electric railway there were always certain standing expenses going on whether the trains run be few or many. The cost of the City and South London line was about £250,000 a mile.

The CHAIRMAN: What will this line cost?

WITNESS: About £500,000 a mile. Continuing, witness said that he had made calculations as to the number of passengers required to be carried to pay a 4 per cent. dividend, and he found that 14,400,000 passengers would be required for that purpose at an average fare of 2d. each person. Working the line 18 hours a day, and carrying 168 passengers per train, that would require a nine minutes' service of trains only. He reckoned they would be able to convey passengers from Baker Street Station to Waterloo in 10 minutes.

Mr. CHARLES SCOTTER, general manager of the London and South-Western Railway, was then examined at this point, and in answer to Mr. Cripps, said he believed the proposed line would be a great public convenience, not only for passengers arriving at Waterloo Station, but also for intermediate passengers. The London and South-Western carried about 50,000 a day into London, and he estimated that about 12,000 of those persons went over Waterloo Bridge into the City. The South-Western Railway were not financing the proposed railway in any way.

The examination of Mr. Greathead was then continued by Mr. POPE, Q.C., who asked: I suppose you agree with me that Northumberland Avenue would be about the most ticklish part of your route?—No; because I do not think any part of the work will be ticklish.

Well, the most risky?—No, because I do not regard any of the route as likely to be risky.

After the witness had been further examined by other counsel, the committee adjourned till Wednesday—they consenting to sit on Derby Day owing to the urgency of the Bills to be dealt with.

The sittings of the Select Committee were resumed on Wednesday, June 1st, when consideration of the Waterloo-Baker Street project was continued.

Mr. PEMBER, for the promoters, read a suggested clause prepared by the clubs and other owners in the vicinity of Northumberland Avenue. In it it was laid down that the portion of the subterranean railway passing under or near the avenue should lie at least 10 feet below the surface of the London clay, that it should be constructed in sections under the compressed air system, and the petitioners should from time to time send an engineer chosen by them to inspect the workings, that he should be given all needed facilities, that the company be responsible and liable to pay damages for any injury done to property undermined, that no station for the generation of electricity be established within a hundred yards of petitioners' property, &c.

The CHAIRMAN here intimated that the committee would sit again on Thursday and Friday, and then adjourn for the recess.

Mr. GREATHEAD, joint engineer in the Waterloo-Baker Street scheme, was recalled. In answer to Mr. Freeman, who appeared for the County Council, he said the line would have, in all, five stations, including the termini, and the platforms, which would be underground, were to be larger than those of the City and South London Railway. The waiting rooms, also, would be underground. One of the stations would be at Piccadilly and one at Oxford Circus. They had taken only sufficient land for the requirements of the buildings, and were under the General Building Acts of the metropolis. That matter was discussed in the Central Railway Bill, and if it was put in that he would not object to it now. The electricity generating station would be placed on the south side of the Waterloo Station. The line would go near the great sewer in Regent's Park, but would not interfere with it. The tunnels at that point would be in the London clay. They hoped to make a shaft on the other side of the river, not on the Middlesex side. Clause 46 of the Bill showed that proper safeguards had been taken not to damage any property, or to place any in danger. In 1884 the length of the South London line was 1½ miles; now it was 3 miles. It had carried 27,000 passengers in one day, but the average was 14,000. He calculated in 1883 that the line on an average would be used to the extent of one-half its full capacity, and that proved to be accurate. Last year, throughout each day, the coaches were about half filled. The experience gained in 1884 would be useful in the making the new lines. When the South London line was in making, they had no idea of using electricity on it, but meant to lay down cables. The rapid advances in electrical science during the construction of the line was the cause of their altering their plans. He estimated that the cost of working the new line would be 45 per cent. of its earnings—£50,000 as to £30,000 compared with the South London line, the equipment being much more expensive, and the stations larger. The South London cost £300,000 a mile; the cost of the new line would be £550,000 a mile—nearly double. The estimate was about £1,300,000, inclusive of equipment. To pay 4 per cent. on that sum they would have to carry some 14,000,000 passengers per annum; that was a reasonable estimate. He had put the average fare at 2d., the same as on the South London. When the Metropolitan was a single line it carried over 23,000,000 passengers a year. The average fare on the latter also was 2d.

Mr. GALBRAITH, joint engineer in the scheme, said the line would be a very great convenience to persons wishing to get from Baker Street to Westminster, as he himself did daily when going from home to his office. After giving details of the omnibus traffic in the neighbourhood of the proposed line, witness said: From Baker Street to St. John's Wood traffic was very much increasing. At one time from his house he could see to Harrow; now he could see nothing but houses. At Baker Street the new line would not interfere in the least with the Metropolitan Railway station. There were 750 omnibuses daily each way on the Baker Street route, and all were full. He had had interviews with the engineers and manager of the Metropolitan Railway, and tried to meet them in every way. He did not know that the existing Metropolitan station at Baker Street was to be enlarged. There would be a retaining wall made by the new company at Baker Street, and they would in no way interfere with the existing station; the new station would be 23 feet below that of the Metropolitan Company. That company had latterly ignored the promoters of the new line. Col. Wheatley had told him that as long as the portion of the tunnel under Regent's Park was in the London clay, it would be no detriment to the Park, and that he would not object. The company were under an obligation not to break the surface of the Park. The station at Piccadilly would be close to the Criterion. It would be a great public convenience. They would not interfere with the South Eastern property in any way at the present level of that line. The new station at Charing Cross would be 17 feet below the rails of the present Charing Cross station. There was sufficient land there, and he was certain there would be enough traffic to satisfy the capital involved. In the evening there would be a good deal of traffic by theatre goers—ladies and gentlemen in

evening dress, probably. This section of the public did not use the South London line much, because it had only one class. He thought the new line should possess two classes, first and second. It would not be so well to put the Baker Street station on the other side of the road—it would be more costly, and less convenient. He believed that Lord Portman, who had consented to the station proposed, would have dissented from the one now suggested—on the other side of the road. They wished to meet owners in every way, and would in no case interfere with the Metropolitan line or station. The sewer in Marylebone Road was 8 feet below the Metropolitan Railway, and the new line would be at an ample depth beneath the sewer. In the construction of the underground stations, they would be under covenant to do all that was reasonable to secure the safety of the sewers and piping. It was intended to put the generating station on the south side of the river—one of the arches of the Waterloo Station would be a very good place for it. At the Hotel Victoria the London clay was 50 feet below the surface. It was cheaper and better to construct in the clay; but they did not want to be driven needlessly down. In Northumberland Avenue it would be best to have a series of close borings, to ascertain the proper depth to go.

Mr. PEMBER said he was glad to state that they had settled with the National Liberal Club, but, though good unionists, they had not been able to settle with the Constitutional Club. He hoped that disunion would not continue long. (Laughter.)

WITNESS said that in College Street, where the tunnels crossed the river, being public property, they did not propose making arrangements with private owners.

Mr. PEMBER mentioned, with respect to the suggestions contained in the proposals of the "Northumbrians" (as he called the representatives of the owners in Northumberland Avenue), that they had arrived at the basis of what promised to be a satisfactory arrangement.

WITNESS: There will be no damage at Sufferance Wharf by vibration or any other cause. If there be, Mr. Howells will be paid for it. At the great hotels there will be no vibration felt from the railway.

Mr. PEMBER: There are more than 700 omnibuses on the road in the City, and in one year the number of passengers carried by them was over 400 millions.

Mr. GREATHEAD, in reply to Mr. STANLEY LEIGHTON, said the traffic taken up by the new line would be that now dealt with by omnibuses. He explained the character of the works, conducted under compressed air, and said the workmen stood it well. Some portions of the line would be made in this way.

After luncheon,

Mr. PEMBER announced that he had settled with all the clubs, even the Constitutional, so that the only opposition now left to the preamble was from the two railway companies, which Mr. Littler represented, and Mr. Howells. That would be the case for the Bill on the preamble.

Mr. D. HARTE addressed the committee on behalf of Mr. Howells, complaining that his client alone had been scheduled in the Bill, and urging that he ought to be protected from injury. If the Bill passed in its present shape, Mr. Howells could not obtain damages if the line under the wharf did him injury.

Mr. FULLER said the property of Mr. Howells was not on very firm ground, and it was probable that the tunnel passing under it would injure the buildings. Mr. Howells, the lessee, with six years of his lease yet to run, was under stringent obligations to hand over the property in perfect condition. If the line went up College Road it might disturb the foundations of Howells property.

Mr. PEMBER said if there was a meeting between the parties no doubt an arrangement could be come to.

Mr. LITTLER pointed out that the line in question was absolutely useless for ordinary railway traffic, and that it would not carry luggage or goods. If the line were made as proposed, it would indefinitely postpone extensions contemplated by the companies he represented. The Charing Cross line cost £1,000 a yard, and if the makers of such a line were to be told that they were to have no local traffic, and that they were not to compete for that kind of traffic, it would be strange. The line now proposed was useless and stupid. It would carry no traffic—or traffic not sufficient to justify its own existence, but sufficient to annoy other people. It would enable Mr. Galbraith, an eminent engineer, to get from home to his office very cheaply, instead of spending 1s. 6d. on a cab; and that was the only good the line would do. It did not touch the line of congested traffic—the Strand, Piccadilly, and Oxford Street. The line would not take people out into the suburbs or the country, but only from Baker Street to Waterloo—mere omnibus traffic; and though it would be a cheap mode of travelling, he could not admire the taste of the person who chose it. The line would be useless, and a failure, like the present South London line, which carried only 14 passengers per train mile, notwithstanding that it passed through a congested working-class population. The Hampstead line, and that of the Great Northern Company, were different; they would convey passengers into the suburbs. The ordinary shareholder did not get a penny out of the District Railway; it did not pay, because it was in competition with the omnibuses all the way, as this line would be. There was a line under Holborn, which, like the South London line, was a lamentable failure. Mr. Greathead once prophesied that the new line would earn 5 per cent.; now he said 4 per cent. This resembled his prophecy in respect to the South London line, and was as sure to be falsified by events. The Great Northern and the South Eastern meant to get through London with their main lines, but these underground railways would make it far more difficult for them to do so.

The committee adjourned till the next day (Thursday).

The Select Committee on the above matter resumed its sittings in the House of Commons on Thursday, Sir John Kennaway, Bart., presiding.

The CHAIRMAN called the agents of the Great Northern Railway, and arranged with them for the taking of their Bill at the close of the present enquiry.

Mr. LITTLER said he thought the case of the Bills behind this one was absolutely hopeless, and he hoped the present one would not pass. No harm would have been done, however, as the Bills could be held over till after the Whitsuntide recess.

The CHAIRMAN: I hope we shall be able to finish the present Bill to-night.

Mr. LITTLER: I think so, sir. The opposition from Northumberland Avenue seems to have been withdrawn.

The CHAIRMAN: Then I hope we may be able to get through with the Great Northern and City Bill to-morrow.

Mr. LITTLER, continuing his address in opposition to the Bill, said the promoters could only borrow for their lines at 5 per cent., apparently. They wanted £35,000, but had so far been able to get only £9,000 of it; presumably, they could not get their stock taken up. The South Eastern Company, though they had gone to very great expense with that object, had not been able to cope with the excessive traffic along their line, and for years they had been preparing for enlarging their station at Charing Cross. For this purpose the South Eastern had acquired the freehold of nearly all the property on the east and west sides of Craven Street, with buildings fronting the Strand, the whole of the tenants of which were under terms to quit, if required, at six months' notice. For the last ten years the South Eastern had been "paying through the nose" for this property, as the short terms of the letting prevented their getting as good rents as if long leases were granted. If these people wanted to put a station near Craven Street, why did they not go into Northumberland Avenue and spend their own money, and not interfere with the South Eastern. A more monstrous interference with the property of other people he had never heard of. The South Eastern, since 1882, had been paying a rental of £11,000 a year for property to be used in the proposed extensions. He would next deal with the case from the Metropolitan point of view.

Sir MYLES FENTON, general manager of the South Eastern Railway since January, 1880, said his company had for years contemplated extensions and the making of a junction between their lines and those of the London & North Western Company and other lines running to the north of London. They already had communication with the Midland and Great Northern by the Blackfriars Junction. It would be an enormous advantage to the South Eastern to secure through communication with the London & North Western. This would give them traffic on the north side of the City, as well as much suburban traffic. The traffic between the north and south of the Thames was daily increasing. The South Eastern extension lines would be on the surface, so that people would not have to be hoisted in lifts. The Charing Cross and London Bridge Railway, which was probably the most expensive in the world, cost about £4,000,000, or £1,000 a yard. It would cost still more yet. If these electric lines were made it would be practically impossible for the South Eastern to carry its lines through the City as they wished. The original Metropolitan cost about £750,000 a mile. The extensions of the South Eastern would be similar in detail, and cost about the same.

The CHAIRMAN: Do you think the Sheffield line will be able to make its extension to London within the next ten years?

WITNESS: Certainly, before that time.

Mr. BRADY, the next witness, said he had been engineer of the South Eastern Railway for about 40 years. His company had been preparing for extensions for some years, and that at present they could not cope with the traffic that came to them. So far back as 1876 he saw the necessity of having a station that would cover Craven Street, that was part of the scheme they now had in view, and it was for that purpose that they had acquired the land there. It was their intention to close Craven Street, with the permission of the County Council, and have a two-storied station, partly to deal with the goods traffic to Covent Garden market, and partly for the light Continental parcel traffic. That would be disposed of early in the morning before the heavy passenger traffic commenced. The best situation for the station of the electric railway would be under the bridge, on the Embankment.

Mr. WOLFE BARRY, engineer to a number of important railway companies, said the railway they were now making through the heart of Glasgow would cost about £250,000 per mile. It was very valuable to have main lines running through a city, as they would carry suburban traffic. His own idea was that the city lines should not rest in the city at all, but run right through from side to side, and rest in the suburbs. Witness gave particulars of the failure of previous schemes for the construction of lines through London, and detailed in what manner a through *route* across the City ought to be made. He was strongly in favour of a full-sized railway, like the Metropolitan, and disapproved of these underground lines for omnibus traffic only. Omnibus competition was so severe that, were it not for the suburban traffic, the two circle railways would have to be discontinued. The proposed line would take away from the ordinary railway much of the purely passenger traffic that would be needed to make it a success. The tubular railway would not deal with luggage at all. Witness, and the late Sir John Hawkshaw, were the engineers in the construction of Charing Cross Station in 1864. That station had not been enlarged since it was built, and now needed widening very much on the west. He thought the space under the bridge would be more suitable for the proposed station of the electric railway than the site in Craven Street, which it was proposed to take from the South Eastern Company. He did not believe in this 11-feet tubular railway—it was far too small. The great want of London was through communication by the big lines—the South Eastern and the Great Northern Railways. The electrical locomotive had no doubt reached a great degree of excellence and perfection, but it could not be pretended that it was yet able to compete with the steam locomotive. He thought the Bill under consideration

was a very bad one, but that the time was coming when electrical railways would be brought into general use. There were no through trains in the continental traffic in London, so that he could not say how many passengers of that class would have to be dealt with. Two main lines of communication going through the City were thought enough for Glasgow and suburbs, with its population of 750,000. A similar line might not suffice for the needs of London, but it would be very useful—better than nothing, as at present.

Mr. EDWARD RYDE, past-president of the Surveyors' Institute, and for many years chief surveyor to the South Eastern Company, said it would be a very disastrous thing for the two Companies (the South Eastern and the Electric) if the new station of the Electric were allowed to be put in Craven Street, in the heart of the property of the South Eastern. The South Eastern Railway ought not to sell land in Craven Street, at any price. It was worth more than fifty years' purchase.

Sir FREDK. BRAMWELL, consulting engineer of the South Eastern Company, said that the proposed line, if made, would be a serious hindrance to a real line being made, when the time came. There was no necessity to put a station in Craven Street. Both ends of the line were arranged in a very objectionable manner. He did not like to joke before the Committee, but it looked to him as if the plans of the Waterloo-Baker Street scheme had been made in a spirit of "pure cussedness." (Laughter.) He did not object to electrical railways at all, as there was a great future before them. It would be better to have 16-ft. tubes, not 11-ft., as here proposed.

Sir BENJAMIN BAKER, engineer, said he acted in conjunction with Sir John Fowler in the construction of the Metropolitan Railway. He was altogether opposed to the present scheme, as unsuitable and inadequate. He thought Sir Edward Watkin desired to make the South Eastern Railway and the Manchester, Sheffield, and Lincolnshire Railway extension to London connect, looking on them, evidently, as one scheme. The present scheme would seriously interfere with the carrying out of that idea. Witness had no other objection to the scheme, as that of an omnibus line.

Mr. SEATON, engineer to the Metropolitan Railway Company, objected to the scheme, because the top of the proposed tunnel, at certain portions of the line, was only 4 feet 6 inches below the metals of the Metropolitan Company. He also thought that the Baker Street station of the proposed line should be on the other side of the road, and not close to that of the Metropolitan. The latter desired to extend northwards; but if the Electric Railway Company made their line as they wished, it would be impossible to do so.

Mr. BELL, manager of the Metropolitan since the retirement of Sir M. Fenton from that position in 1880, said the proposed railway followed the omnibus line all the way, and would probably get a similar average fare, viz., 1·12 pence. The omnibus owners would take precious good care that the electric line did not clear the streets of traffic of that character. He did not think the scheme a good one in any way.

Mr. LITTLER, speaking on behalf of the Metropolitan and South-Eastern companies, said the proposed line was extremely badly laid out, more particularly at the *termini*. There was an unwarrantable attempt to interfere with the property of other people, and if the line were made, it would prevent the extensions contemplated by the South-Eastern Company and the Metropolitan Company.

The committee then adjourned till Friday.

The committee resumed on Friday morning, Sir John Kennaway in the chair.

Mr. LITTLER, continuing his address, said he need not say anything more about the Metropolitan property, but would show how the proposed line would affect the Metropolitan, and the effect it would have as interfering with the scheme for through communication, north to south. It had been shown that the main object of the electric scheme was to give communications east and west, where there were swarms of omnibuses, whereas on the route north and south there were very few. Mr. Greathead, in fixing his average fare, was 25 per cent. out, as it would be 1½d. and not 2d., so that he would require 19,000 or 20,000 passengers a day, instead of 14,000. The traffic on this particular route would not suffice for the dividend needed, and he was sure his friend, Mr. Pember, would not sink his fees in an elongated pipe of this description. The City and South London line, which had the advantage of having only one class of passengers, and which cost only half the sum which this railway was expected to cost, was not a success, and did not pay; then how could they expect the present scheme to pay, with its two classes of carriages? The South London Railway cost £250,000 a mile; this one would necessitate an outlay of £560,000, or £600,000 per mile. He submitted that the preamble of the Bill had not been proved, nor had it been proved that the line would pay. One of the witnesses whose presence was much desired was found to have another engagement on Derby Day, strange to say, and in this and other ways valuable evidence had not been forthcoming, which, even on the last day of the session, would justify the most strenuous opposition. It would not do the least harm if the Bill were allowed to lie over till the next session, or the next Parliament, as was done with a similar measure in 1886. The proposed line had a most objectionable route; it was marked with all the defects that a line could have; it had not any recommendations in its favour whatever, and from the point of view of public convenience, or of wilful damage it would cause to the Metropolitan and the South-Eastern, it would be most mischievous to permit such a Bill to pass. Mr. Littler next addressed the Committee in behalf of the Thames Conservancy Board. The line would cross below the river at a depth of some 6 feet from the bed, and the board said there was no reason why the proposed line should not pay compensation to the public, as other people did, for the privilege of using the subsoil of the river.

Mr. FREEMAN, on behalf of the hotel owners of Northumberland Avenue, said his clients should be protected, not only as to their buildings, but in their right to claim damages if, in the construction of the line, injury were done through any failure in the works. The hotels, which were very prosperous, and which had obtained for themselves the best position in London, were on ground that might give way, in parts, if it were undermined in any way. The owners of the Victoria Hotel spent over £80,000 before their foundations were secured, the massive building being over the bed of an old stream.

Mr. PEMBER, replying, said the opposition to the preamble was practically reduced to that of the South-Eastern and Metropolitan Companies, as the clubs and hotels of Northumberland Avenue had been satisfied, with the exception of a single word, in the clause agreed upon. The County Council, who had always been in favour of the principle of the Bill, were also satisfied. This Bill proposed to give coolness instead of heat, cleanliness instead of dirt, light instead of darkness, pure air and plenty of it, instead of the stuffy, stifling atmosphere found on the circle railways.

The CHAIRMAN: In these tubes?

Mr. PEMBER: Yes.

The CHAIRMAN: I have not had experience of the electric railways, and therefore cannot speak as to your accuracy.

Mr. PEMBER: Try the South London line. That is not a good specimen of the electric railway, because it has only 10-feet tubes instead of 12-feet, as in our case; but even that gives all these things. Our line gives essentially an underground omnibus service, with trains every two minutes instead of every 10 minutes, as on the Metropolitan. Whatever the South Eastern Company may say, the public don't want the projection of heavy traffic through the City to interfere with the rapid transit of passengers. The average fare on the Metropolitan is 1·9 pence. If we get the same our revenue will be far more than sufficient to pay a substantial dividend. In 1867, when London had only half its present population, the Metropolitan, with only 4½ miles of road, carried 27,000,000 of passengers. If that was the case in 1867, how much greater would be the traffic on the line now proposed.

The CHAIRMAN asked what probability was there if this Bill passed, that the line would be carried out. Mr. Littler had said that nothing had yet been done in the matter.

Mr. PEMBER said they had thought it best to wait for the passing of the Bill, but there was not the shadow of a doubt that they would be able to get their money, or that the line would be made if the Bill met with favourable treatment. There was no opposing scheme, except in the minds of Sir Edward Watkin, Sir Benjamin Baker, and Mr. Wolfe Barry, among whom there were no less than four distinct plans, all of which involved tunnels of brick like those of the present Metropolitan, because ironwork was too costly. Looking at the opposition as a whole, was London, with its enormous demands for better means of traffic, to stand still for that. He was sure the committee would not entertain such a suggestion.

The CHAIRMAN, after the committee had conferred together for some time, said they were of opinion that the preamble of the Bill was proved. They gave to the Hotel Victoria a special clause of protection, similar to that given in the Central London Bill to the Equitable Insurance Company. In regard to the question whether the land ought to be taken from the South Eastern in Craven Street, as the South Eastern would perhaps like to call their engineers or give further evidence, they would reserve their decision. The question raised in behalf of the Thames Conservancy was one of clause.

Mr. LITTLER said the matter referred to was only a portion of the South Eastern case.

Mr. FREEMAN said he appeared, and was speaking for and on behalf of the Victoria Hotel, the Grand Hotel, and the Hotel Métropole, not for the Victoria only.

The CHAIRMAN: I understood that the Victoria was based upon very different soil to that of the other hotels.

Mr. FREEMAN: The Métropole is really worse than the Victoria, as a matter of fact.

The CHAIRMAN: Then you appear for the three hotels.

Mr. FREEMAN: Yes.

The CHAIRMAN: We will reserve our decision in that matter.

Mr. FREEMAN asked for costs on behalf of his clients.

The committee refused the application.

Mr. HARTE, for Mr. Howells, of Sufferance Wharf, also applied for costs, on the ground that he had been brought there vexatiously.

The CHAIRMAN said the committee had no power to grant the request.

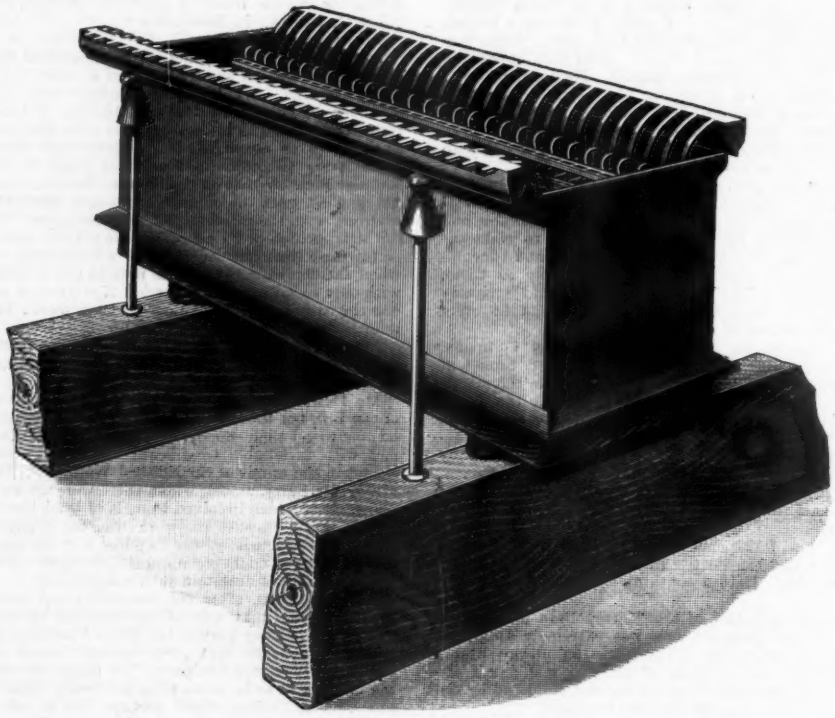
The committee next proceeded to the consideration of clauses, refusing to give the Thames Conservancy any special measure of protection.

The Conductivity of Certain Phosphates.—Lenz has shown that the salts of ammonium and potassium with strong acids show equal conductivities in dilute solution, and D. Berthelot has demonstrated that with feeble acids, the two conductivities are distinctly different although remaining approximately the same, whilst with phenol they are very different. In a paper which may be consulted in the *Comptes Rendus*, cxiii, pp. 851—854, Berthelot shows that the conductivities of the monobasic potassium and ammonium phosphates are identical; with the bibasic phosphates, the conductivity of the ammonium salt is about six per cent. lower than that of the potassium salt, whilst, with the tribasic phosphates, the two conductivities are widely different, that of the potassium salt being much higher.

THE SUPPLY OF ELECTRICITY IN BRADFORD.

THE supply of electricity in Bradford is perhaps of more importance than usually attaches to an electric light installation, because it is the first instance of a town authority successfully combating the difficulties inseparable from a public service of electric light. The social duties of municipal authorities are so strongly urged nowadays that it need not be surprising to find communal control initiated by an attempt to work electric lighting stations. How far success will attend these efforts remains to be seen. Local bodies are to a great extent in the hands of their technical advisers, and though these advisers may be all that is desired, still there are so many conflicting interests which come into prominence, that works undertaken by corporate authorities often cost a good deal more than those undertaken by private enterprise.

A municipal body which does the lighting is in some respects, more handicapped than a company, for there must always be a moral right to supply the electric light to the poorest ratepayer, inasmuch as the necessary capital is borrowed on the security of the rates. At the same time, a municipal authority with its knowledge of local wants, together with its organised staff, ought to be able to maintain an electric lighting station with great economy. The Board of Trade, in their wisdom, however, select the district to be first lighted, thus diverting the onus from the elected body.



CROMPTON-HOWELL CELL.

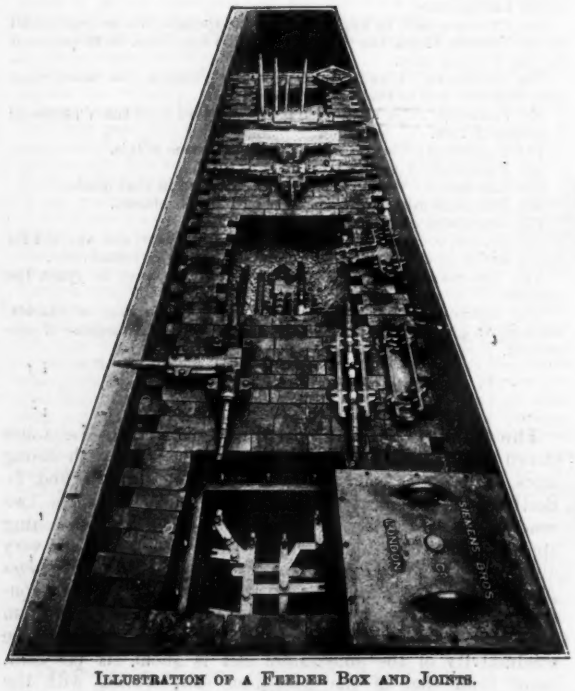
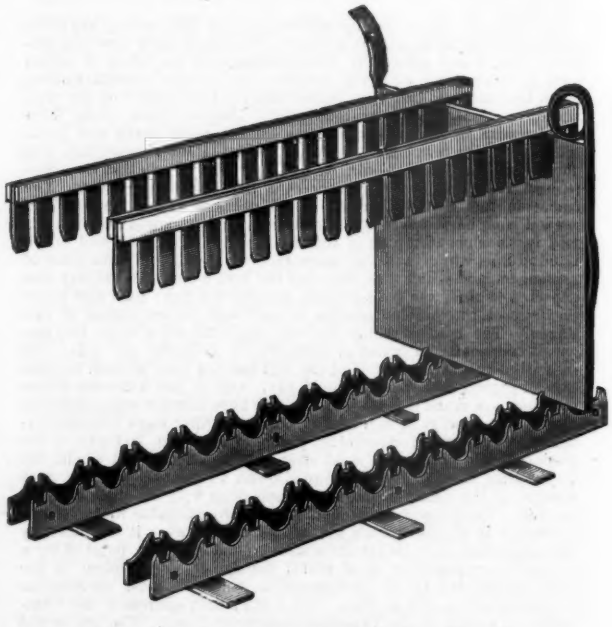


ILLUSTRATION OF A FEEDER BOX AND JOINTS.



CELLULOID SEPARATOR FOR CROMPTON-HOWELL CELL.

SCALE :—

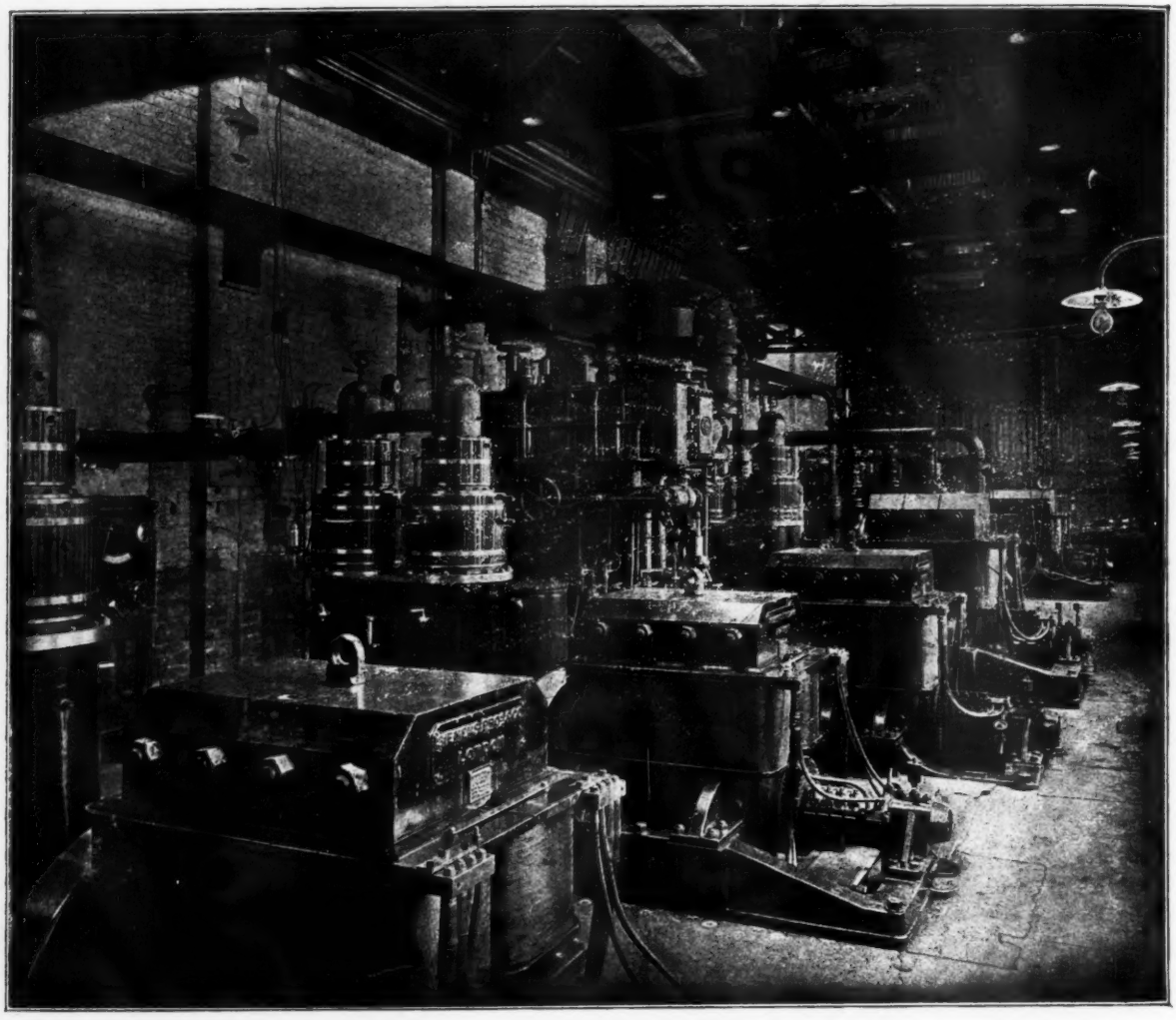
— Central Station — Boundary of district to be lighted; ..... Streets in which mains are now laid.

MAP SHOWING THE BOROUGH OF BRADFORD.

D

We do not think that the example of the Bradford Corporation can be overestimated. The central station is an object lesson to all municipal authorities, for it proves beyond all doubt the possibility of a central station being erected and most economically maintained by a corporation.

The fact must not be overlooked, however, that the district now supplied is probably the best in the borough, and the economical results now present might fade away in the event of the corporation endeavouring to light a straggling neighbourhood. The Borough of Bradford is a long scattered district five miles by three, and includes besides the town proper, several large townships, some of which are, perhaps, three miles from the centre of the town. The Bradford Corporation has a laudable desire not only to supply the whole of the town, but to go outside and give the light to Allerton, Little Horton, and Great Horton. The somewhat dangerous analogy



GENERAL VIEW OF CENTRAL STATION.

of the water is used as a reason why they should do this, but a reference to the map of the whole district will show that to introduce electricity all over the borough will require the most careful consideration and forethought.

The Provisional Order under which the electric lighting has been carried out was obtained as far back as 1883, but it was not until September 20th, 1889, that the corporation commenced to supply electricity in the centre, or shop district, of the town. After much discussion a system of continuous low pressure, distributed by two wires, had been decided upon. To this determination the council were mainly guided by their adviser, Mr. Shoolbred, C.E. The central station is built on ground owned by the Corporation, and at the present moment consists of a ground floor, nearly the whole space being occupied by the plant now in use. The station appears to have been designed in such a manner that extensions will be easy, the original plans, in fact, contemplating a two storey building, capable of holding machinery with three times the output of the present plant. The station is now worked at its full load, and to meet the rapidly growing demand, large extensions will be made shortly.

When the station was opened in 1889, the following generating plant was installed:—Three Lancashire steel boilers of 180 H.P. each; two Willans II central valve engines, each of 150 I.H.P.; one Marshall double acting steam engine of 150 H.P., coupled to Siemens's shunt wound dynamo.

The high-speed direct-driving engine was not permitted to enter mill-owning Bradford without a struggle. Local feeling, based solely on mill work, recognised no power save that derived from slow moving engines and belts, and no small amount of argument was necessary to combat these prejudices. When admitted into the town the performances of the engines were keenly watched, and perhaps the opponents have a lurking satisfaction in the thought that the engines will lead a short life and a merry one.

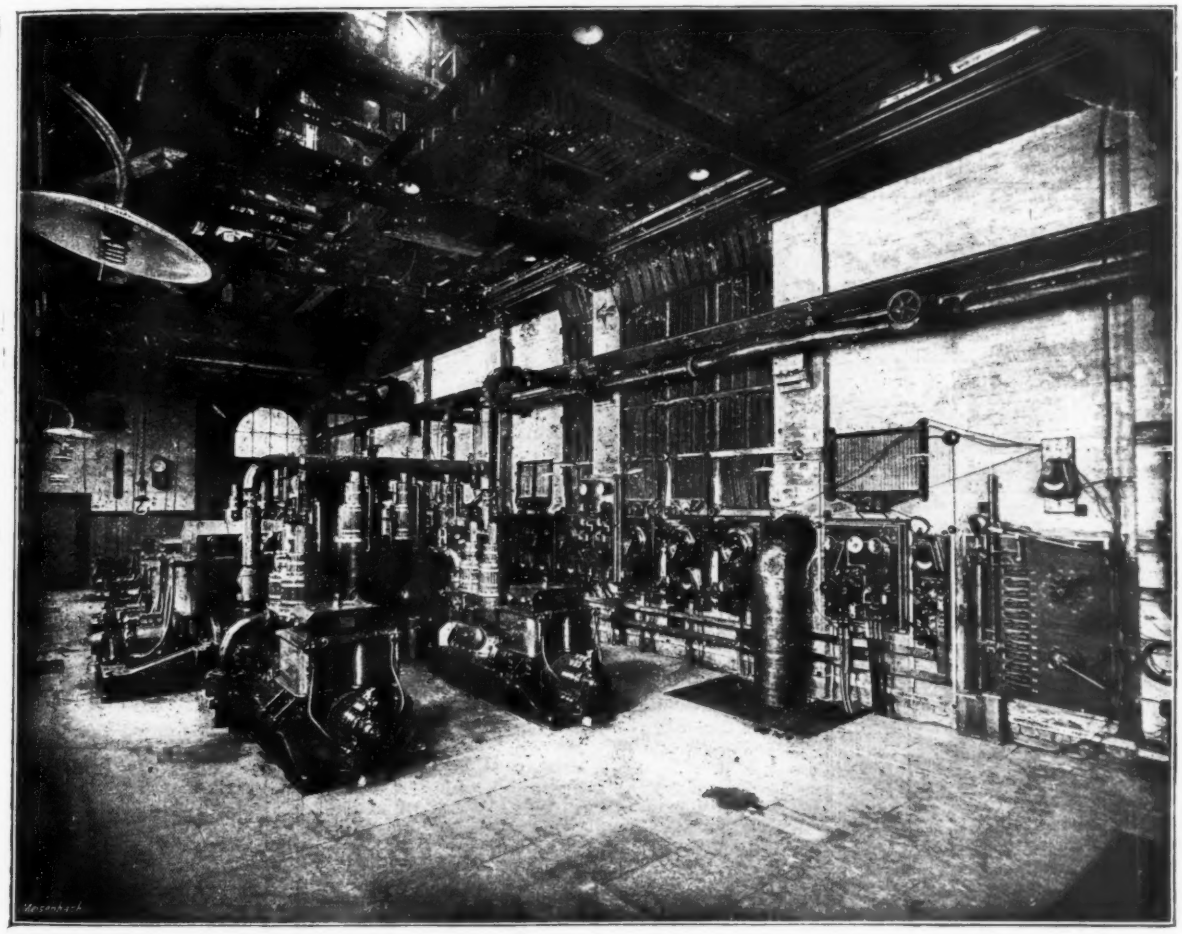
The best index to the demand for the electric light is shown in the frequency with which machines have been added. In 1890, an engine of 300 H.P., the first of its kind ever made, was supplied by Messrs. Willans and Robinson. The type is now well known as the III size. It is merely an extension of the II engine, having three cranks at 120° apart; three low pressure cylinders, 20 inches in diameter, and a 9 inch stroke. This engine is coupled to a Siemens dynamo; in 1891 another Willans-Siemens set, and two sets each consisting of a Willans engine of 80 I.H.P., GG type, driving a Siemens dynamo were added.

About the same time a secondary battery was erected of 70 Crompton-Howell cells of 1,000 ampère-hours capacity. Thus in a very short time the motive power had been practically trebled, increasing from 450 indicated horse-power to 1,200 horse-power, while the maximum rate of nightly output, which at the end of 1889 was 1,400 ampères, was 3,500 ampères at the end of 1891. Due care has been taken to have the units split up as economically as possible, and with the large difference of power in the engines it rarely happens that they are not working to the best advantage.

We have previously described the construction of the large type of dynamos made by Siemens. The combination, shown in our illustration, attracted much attention at the Naval Exhibition, and some interesting tests were there carried out of the efficiency of the combined plant. We believe something like 84 per cent. was said to be obtained.

Three Lancashire boilers, nominally of 180 horse-power, made by Messrs. Holdsworth, of Bradford, were first laid down. They are each of 7 feet diameter and 28 feet long, and work up to a pressure of 140 lbs. per square inch. To one of these boilers a mechanical stoker is attached, which is driven by a motor. A similar boiler is now being added, and, latterly, a Babcock and Wilcox 120 horse-power boiler has been fixed. A feed water heater and Green's fuel economiser are used. The work done by the batteries seems to have been invariably good, and repairs are stated to have been small. We are unable, however, to give figures as to efficiency.

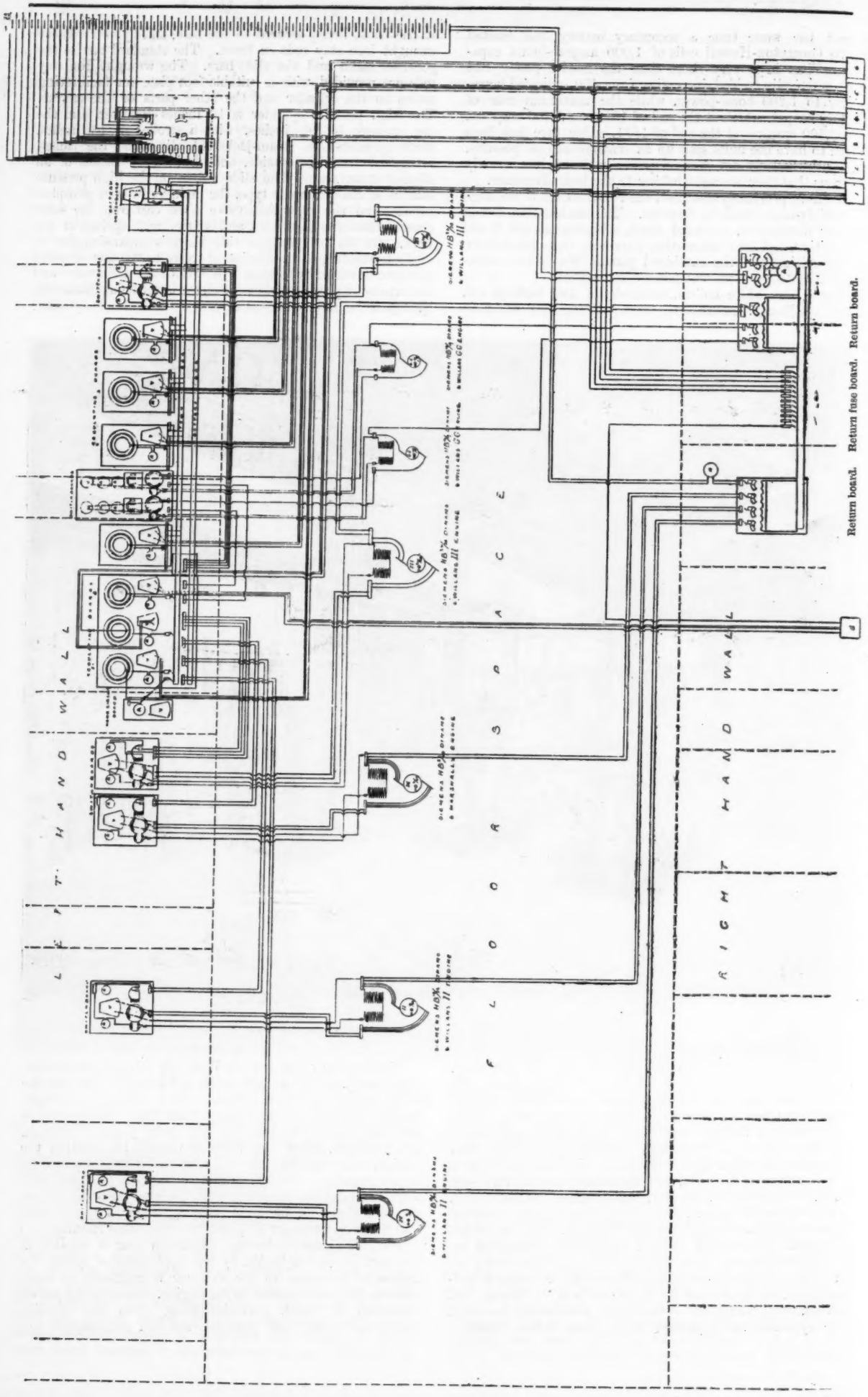
The Marshall engine, combined with a Siemens dynamo, was one of the first to be erected at Bradford. The engine is a compound independent vertical, with patent automatic expansion valve gear. It is mounted on a cast iron bed-plate on which the dynamo is fixed. The engine is entirely self-contained, being carried on a hollow base of strong box section, with which are formed the crank-shaft bearings. The cylinders are supported by a strong hollow standard at the back, firmly secured to the base, and by two massive wrought iron stay rods in front. The standard carries the governor stand and the slide bars. The wrought iron stay rods are provided with a suitable foot plate for facilitating access to the cylinder and the other parts of the engine. The high pressure cylinder is 12 inches diameter, and the low pressure is 19½ inches, with a stroke of 18 inches. Both cylinders are steam-jacketted all round the jacket, being fed from the outside, and drained by means of an efficient steam trap. The slide valves on the high pressure side are of the automatic type, the main valve is of phosphor bronze, and the expansion valve is of cast iron, the same class as that of the cylinder, and is fitted with springs at the back. On the low pressure side Meyer's expansion gear is applied, enabling the admission of steam to the low pressure piston to be varied by hand, at will. Both the main valve and the expansion plates are of cast iron, the latter being fitted with springs at the back. Indicating gear is fitted to each cylinder.



ANOTHER VIEW, INCLUDING SMALL MACHINES.

The starting valve is of the Wing type, fitted with suitable valve and seat, both of gunmetal, and having a long spindle with outside screw and hand wheel, which is brought within easy reach of the engine room floor. The casing is provided with a branch to feed the steam jacket, admitting steam therein, before the valve is opened for starting the engine, thus enabling the cylinder to be well warmed up before running. The low pressure cylinder is provided with a smaller valve for admitting high pressure steam to the low pressure piston to facilitate starting under a heavy load, and the lubricators are arranged for continuous running.

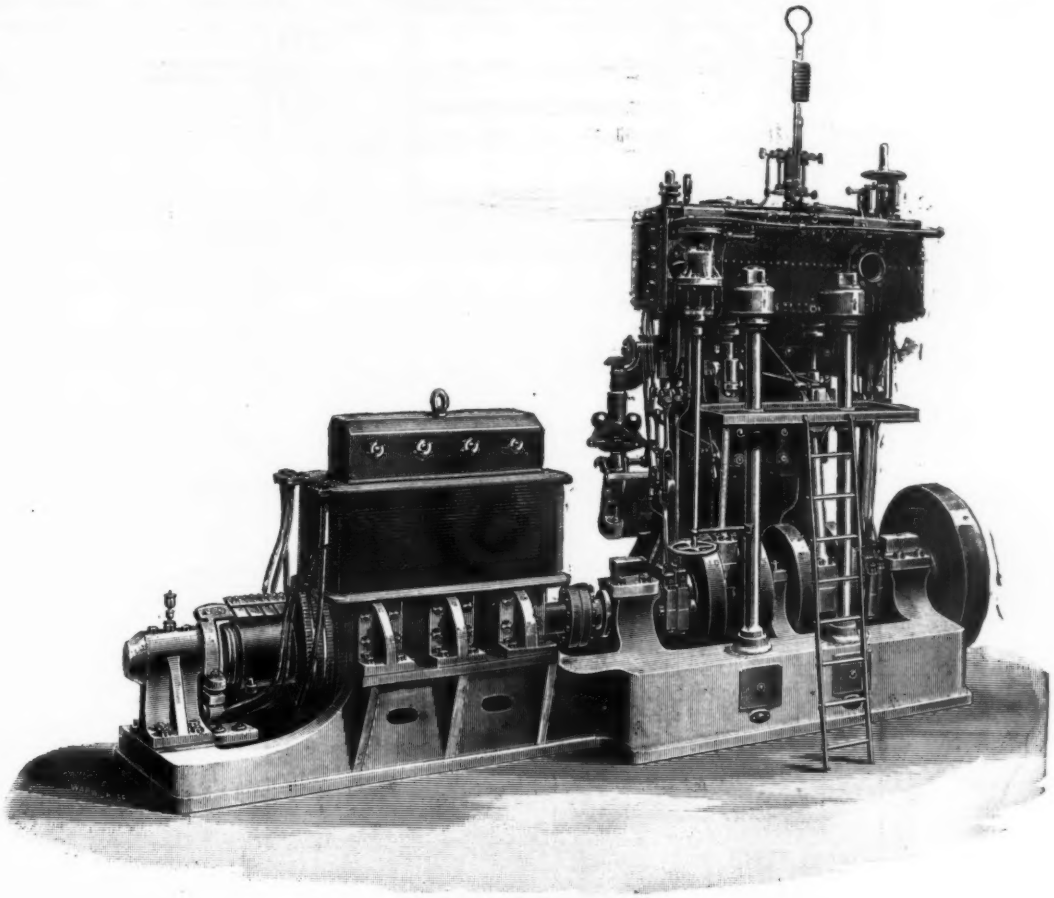
Hartnell's patent automatic expansion gear is applied to the high pressure cylinder, by the application of which the ingress of the steam to the cylinder is regulated in exact ratio to the power exerted by the engine, thus ensuring perfect regularity in speed, notwithstanding great and frequent variations of load, and reducing the fuel consumption to a



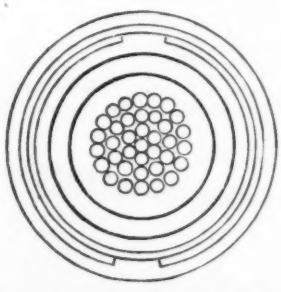
DIAGRAMMATIC PLAN OF BRADFORD CENTRAL STATION.

minimum. An arrangement can also be attached to the governors, whereby the point of cut-off can be adjusted whilst the engine is running.

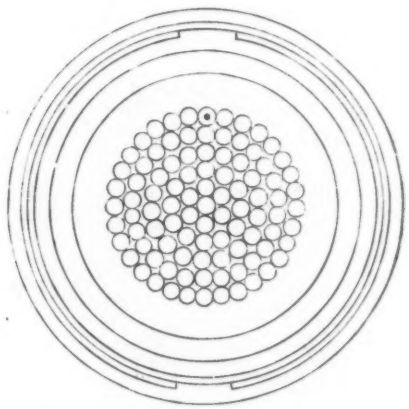
The supply is carried out by feeders, of which there are eight; each main from the station terminates at a feeding centre, from whence a pilot wire is led back to a voltmeter in the station. We reproduce a photograph which will give some notion of what the feeding box is like, as well as the joints and junction boxes. The illustration is not taken from an actual feeding box at Bradford, but is one shown at the Crystal Palace Exhibition, the two are, however, practically the same. All the distributing mains are in a network, which results in the voltage being steady under varying loads. The pressure on the mains is 115 volts. The underground cable consists of a copper conductor, surrounded by an insulating layer of fibre, with a seamless lead casing drawn over it by hydraulic pressure. A layer of well tarred jute or hemp is next placed on this; then comes the mechanical protection in the form of two wrought iron or steel ribbons, each about 1½ inches wide, and wound spirally round the cable, the two ribbons breaking joint with each other. Outside this is another layer of well tarred jute, braided and finished off. This cable is laid direct in the ground, the excavation being again filled in with earth. After about six inches in depth have been filled in, a rough ordinary deal board is laid down over the cable, to serve as a warning, when encountered by a pick or shovel, that an electric main is underneath. Several sizes of feeders are used, the largest having a conductor section of 0·85 square inch, and an insulation resistance per statute mile of 500 megohms. The smallest feeder has a conductor section of ·30 inch, and an insulation resistance of 700 megohms. It will be noticed that in this type of cable, the armouring or protection from external injury is carried directly upon the cable, and that at any point in its length this armouring can be cut and removed, in order to



MARSHALL AND SIEMENS SET.



SECTION OF DISTRIBUTING MAIN.

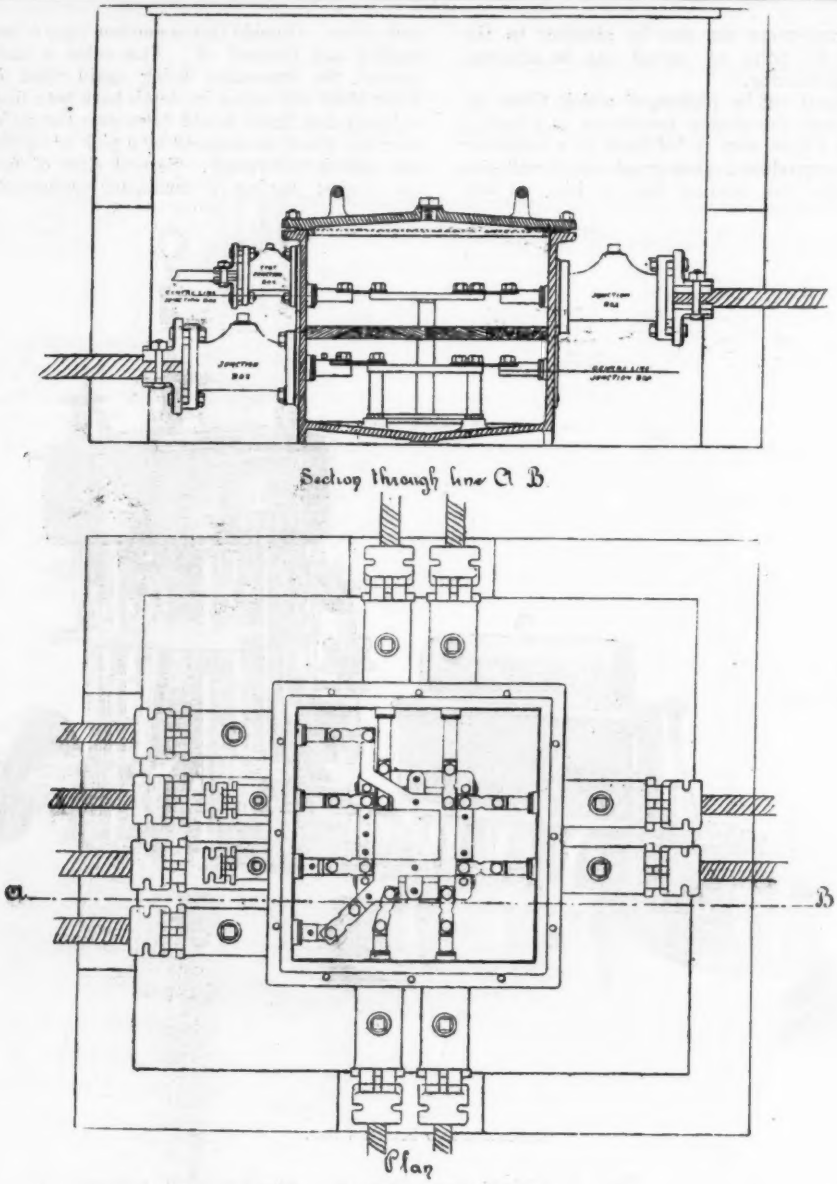


SECTION OF FEEDER WITH INSULATED PILOT WIRE.

DIAGRAMMATIC PLAN OF BRADFORD CENTRAL STATION.

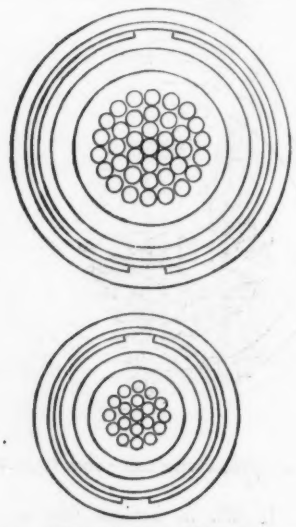
Feeding box.

Feeding boxes. Return fuse board. Return board.



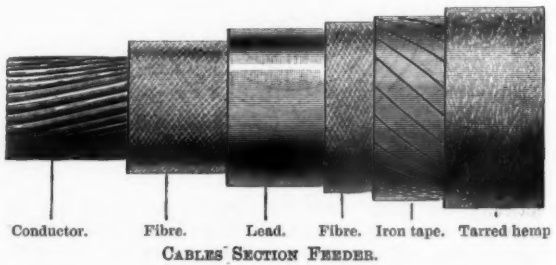
SECTION AND PLAN OF FEEDER BOXES.

SECTION OF A FEEDER.



HOUSE SERVICE MAIN.

make a connection without any detriment to the adjacent parts thereof. All joints with the above-described armoured cables, whether upon the main itself, or for a street branch, or for a house service, are enclosed in a cast-iron case (mostly in an upper and lower half), which, after the joint is made and the whole closed up, can be filled in from the outside with a waterproof composition, so as to make the whole of the interior into a solid mass. The mains are laid, almost without exception, along both sides of the streets under the

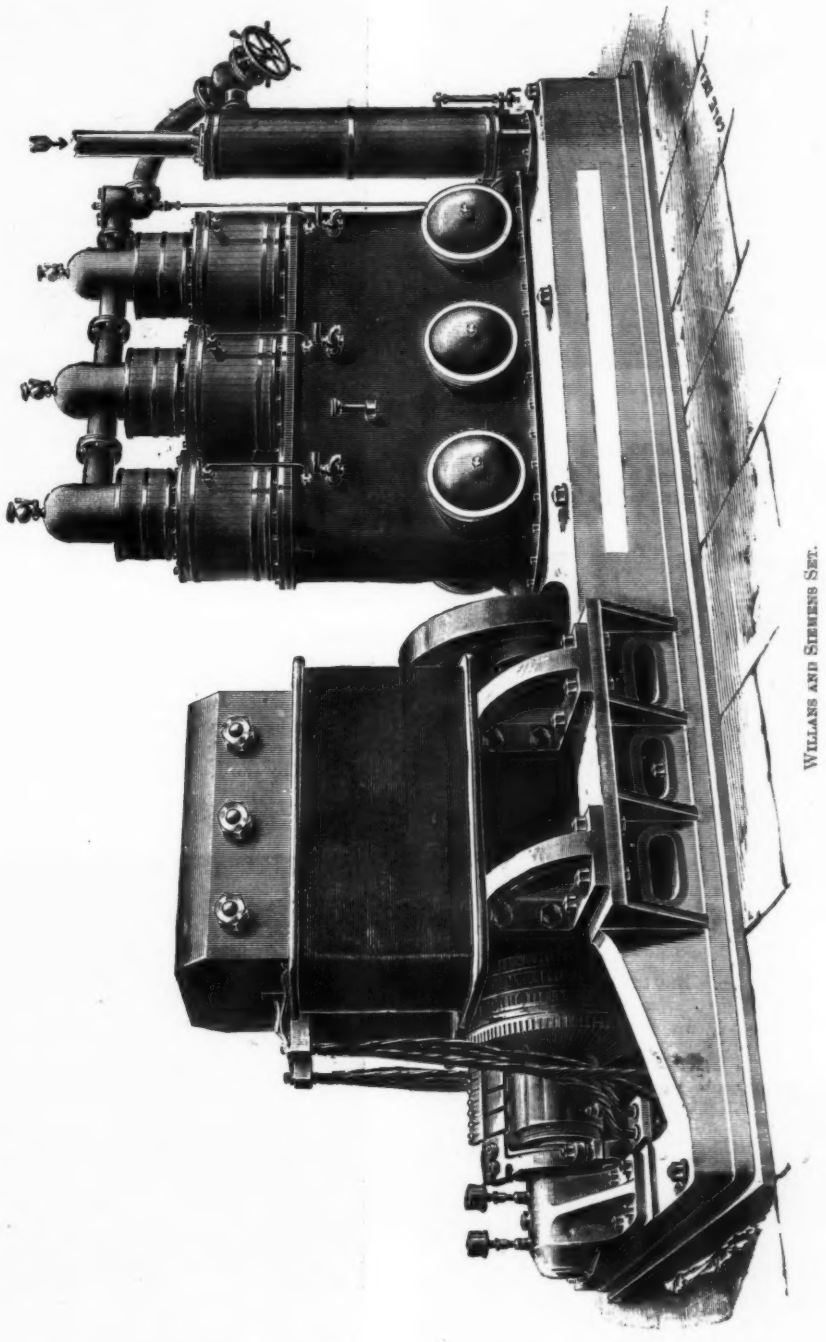


CABLES SECTION FEEDER.

pavement, thus avoiding breaking into the street itself (where the paving is generally expensive), in order to form the house connections, as would have to be done if a single line only had been laid. Cast-iron street boxes of various kinds to suit the several forms of connections, and placed under the pavement, complete the system of distribution, and

afford ready facilities for movable attachments, whereby testing and other operations are much facilitated. We illustrate in plan and section the feeder boxes used. The mains are brought on to tinned copper bars, to which the distributing wires are connected. The boxes are at a depth of about three feet, covered firstly with an iron plate, and then filled up to the level of the street.

Mr. Baynes gives the total leakage between the mains as ·02 amperes = 500 ohms insulation resistance, including



mains, switchboards, dynamos, and a large number of lamps in the circuit.

The most vital question in the Bradford installation is, without doubt, the cost of working the station, and this is important, because the successful results obtained at Bradford will no doubt have great effect on other municipal bodies. For many of the following details we are indebted to the paper recently read by Mr. Shoolbred before the Society of Arts. These figures relate to the work done since January 1st, 1890. For the first few months the daily duration of supply was from an hour before sunset to 11 p.m.; then, owing to a request for an extension of the hours of supply, commenced at 10 a.m., and lasted till 11 p.m.. In February, 1891, the secondary battery already referred to having been fixed, the supply was made uninterrupted throughout the 24 hours, and it has continued so ever since.

It is well known that the nature of the demand for the supply of light (that is, as to the time when it occurs, and as to the duration of such demands) depends very largely upon the character of the district. As previously mentioned, the one here supplied may be described as a "shop" district, with a few moderate sized hotels in it, but without any private residences.

A number of daily curves, some of which are shown in figs. 3 to 7, illustrate fairly the nature and extent of the lighting during that portion of each of the months selected, both in 1890 and on the corresponding day of 1891. Most

of these curves are on a Saturday, which evening was, for some time, one of the heaviest in the week, but now, owing to local changes, is one of the smallest in demand. There

FIG. 3.—CURRENT CURVE FOR JANUARY 2ND, 1890.

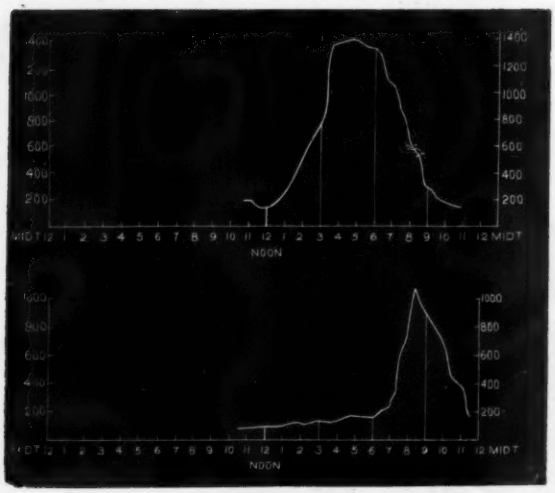


FIG. 4.—CURRENT CURVE FOR JULY 26TH, 1890.

is even now a certain amount of lighting during the day in the basements of restaurants and of other buildings; this demand, of course, varies with the nature of the weather—

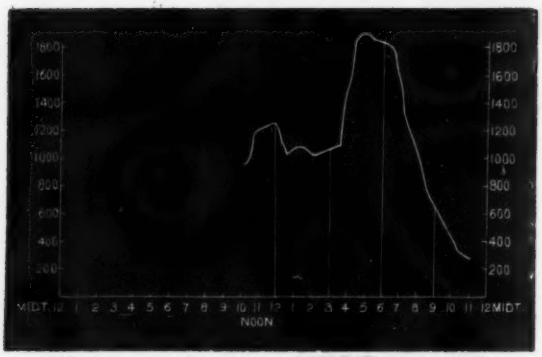


FIG. 5.—CURRENT CURVE FOR DECEMBER 22ND, 1890.

if dark, foggy, or otherwise. But there is another source of demand which is beginning to arise—that for motive power, for which a considerable field would appear to exist in Brad-

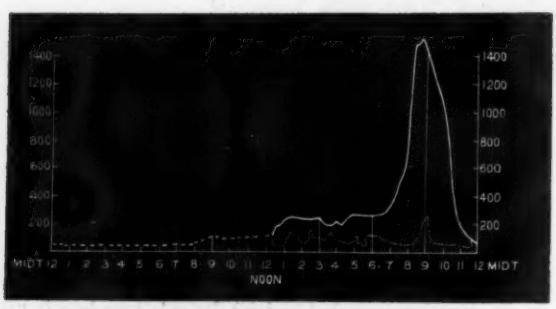


FIG. 6.—CURRENT CURVE FOR JULY 25TH, 1891.

ford. Here dependent upon, and resulting from the larger manufactures of the town, are a number of much smaller industries, where mechanical power is needed in quantity ranging from small dimensions up to that of several horse-power; in a few of these electric motors have been fixed, some even up to 20 H.P. They are used for hoists, lathes, and various other industrial purposes.

The use of motors may, no doubt, help to flatten out considerably the load curve, but we believe that their extensive introduction on the lighting circuit will sooner or later be a source of much trouble. If small manufacturers are educated up to the pitch of using motors for small machines, the probability is that they will use them very often when there

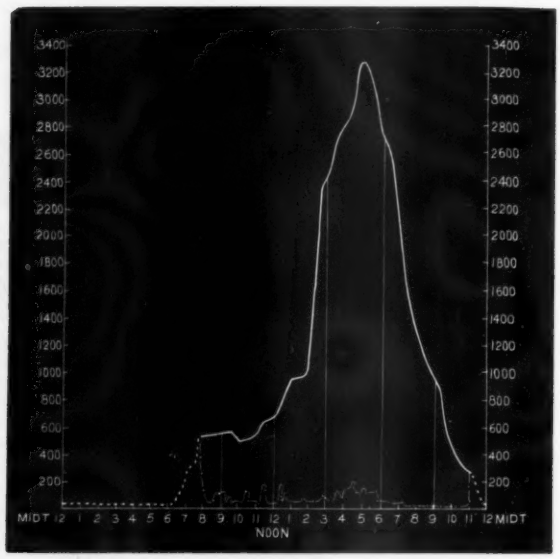


FIG. 7.—CURRENT CURVE FOR DECEMBER 23RD, 1891.

comes an extraordinary demand for light. Once introduce motors, and we must reckon with them day and night all the year round.

Fig. 1 is a diagram showing the total receipts and the total expenditure of production, distribution, sale, &c. These, the running expenses, do not include interest on borrowed capital and sinking fund for the repayment of the capital, as required by the Local Government Board in the case of cor-

FIG. 1.

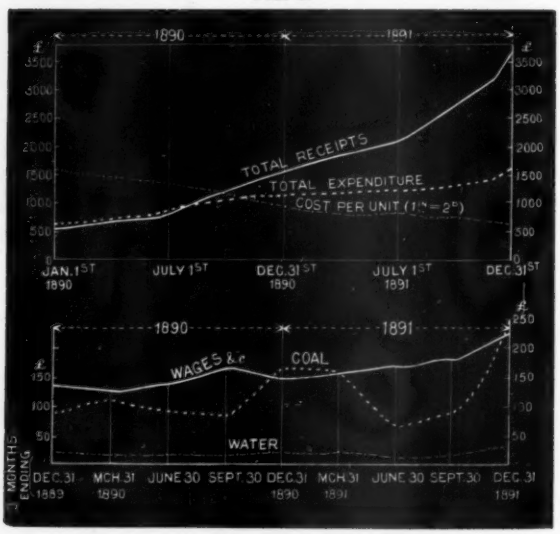


Fig. 2.

porations. Annexed is the table of the profit and loss account for 1890 and 1891, which gives in detail the various items referred to in fig. 1; also the tables of the capital expenditure and of the net revenue account for the same period.

PROFIT AND LOSS ACCOUNT—1890 AND 1891.

Expenditure.	Six months ending June 30th, 1890.	Dec. 31st, 1890.	June 30th, 1891	Dec. 31st, 1891.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Salary and wages...	367 16 8	410 17 10	418 14 3	506 19 0
Coal	246 17 11	247 0 6	292 18 6	341 15 0
Water	33 16 4	34 0 0	34 15 6	36 19 0
Repairs and miscellaneous	100 11 5	204 13 3	266 8 9	431 10 0
Rent of land ...	83 18 2	83 18 1	83 18 1	83 18 1
Rates and taxes ...	46 0 0	104 6 6	67 1 8	69 11 6
Bank interest and commissions ...	19 1 4	89 14 9	95 9 7	120 7 5
Total expenses ..	898 1 10	1,174 10 11	1,261 5 4	1,591 0 0
Cost per unit sold	5·51d.	4·10d.	3·56d.	2·47d.
Total receipts ...	858 14 10	1,552 9 9	2,093 13 6	3,592 1 0
Units sold... ...	39,113	68,794	85,103	154,258

CAPITAL EXPENDITURE ACCOUNT.

	£ s. d.
1889.	
December 31st	18,450 2 4
1890.	
June 30th	25,223 19 11
December 31st	30,464 15 9
1891.	
June 30th	35,370 7 11
December 31st	40,224 19 10

NET REVENUE ACCOUNT.

	£ s. d.	
1891.		
December 31st, debit...	1,079 8 5	Net loss.
1890.		
June 30th, to loss on half-year ...	732 6 11	
December 31st, to loss on half-year...	315 6 0	
1891.		
June 30th	30 5 4	
	2,157 6 8	
December 31st, by profit on half-year ...	971 4 10	Net profit.
	£1,186 1 10	

An inspection of the wages, coal, and water consumption diagram (fig. 2), as well as the rate of production per unit (excluding interest and sinking fund) shows in what a small ratio these items have increased, in proportion to the augmentation, both in the electrical output and in the receipts.

It is claimed by Mr. Shoolbred that this is due, partly, to the fact that the services of the staff have been better utilised, latterly, than was possible at the commencement. To this result the use of the secondary battery has contributed largely by allowing the services of the staff to be confined to twelve hours, on an average, mostly during the day hours instead of being scattered over the entire twenty-four.

The balance sheet issued at the end of last year gave the following as the cost of each item per unit sold :—

1. Coal	for six months per unit sold			·532d.
2. Oil, Waste, Water, &c.	,,	,,	,,	·106d.
3. Salaries for	,,	,,	,,	·543d.
4. Repairs and Maintenance, &c.	,,	,,	,,	·245d.
5. Rent, Rates, and Taxes	,,	,,	,,	·267d.
6. Clerk Management, &c.	,,	,,	,,	·282d.
7. Depreciation, &c. (Interest paid on capital) ...			...	1·10d.
8. Redemption Fund, &c.; Sinking Fund		...	...	·997d.

It will be seen that the items for depreciation, and the redemption fund form by far the largest portion of the account.

The cost of coal is small, the average ton costing little more than 6s. Although its calorific value is not very high, the low price paid more than compensates for this. There are about 19,000 8-C.P. lamps on the circuit, each lamp burning, on an average, from 2 to 4 hours. On an average a 35 watt lamp consumes 20 units. The installation has cost altogether some £40,000.

We cannot conclude this article without referring to the kindness of Mr. Shoolbred, Mr. McGowan, the Town Clerk, Alderman Priestman and Mr. Baynes, who have assisted us in compiling it.

NOTES.

New Continental Telephone Lines.—A telegram to the *Times*, states that the Director-General of posts and telegraphs has opened the two telephone lines between Paris and Antwerp, and Reims and Charleville.

Craigside Hydropathic Establishment, Llandudno.—A very complete electrical installation has recently been put into the Craigside Hydropathic establishment at this place. It comprises engine, boiler, and three dynamos, and a set of 55 K 19 E.P.S. accumulators. There are 420 incandescent lamps, from 8 to 25 candle-power, arc lights for the grounds, and electro-motors for working the laundry, hoist, &c. No expense has been spared to obtain the very best results, both in lighting effect and efficiency. The public reception rooms are brilliantly and effectively lighted, while in the bed-rooms the current is available at any time during the night. The old system of lighting was by means of oil and candles, and this has been entirely superseded in every part of the building, thereby adding much both in comfort and in safety. Mr. William Kingsland, A.I.E.E., has been the engineer and contractor for the work, and has personally supervised it throughout. The lighting has given great satisfaction to all concerned.

The Balloon Society.—At the weekly meeting of the Balloon Society, held at the St. James's Vestry Hall, Piccadilly, the chair was occupied by Professor Unwin, F.R.S., M.I.C.E., and a paper was read by Dr. Julius Maier, Ph.D., on "The Lauffen-Frankfort Power Transmission."

The Taunton Electric Light Works.—A special meeting of the Taunton Electric Light Company was held on Thursday last week, for the purpose of considering the question of the proposed sale of the works to the Taunton Town Council for the sum of £9,300. The following resolutions were carried :—"That the offer of the Taunton Town Council to purchase the company's works and operations, subject to the approval of the Local Government Board and Board of Trade, at the price of £9,300 be accepted." "That the directors be authorised to carry out the said sale in such manner and under such arrangements and conditions as they may think advisable." It was explained that the offer had not come from the whole body of the Town Council, but from a committee appointed to consider the subject.

The Indian Telegraph Department. — Considerable apprehension appears to exist in India with reference to the inconveniences which may arise from the undermanning of the supervising staff of the Indian Telegraph Department. It is pointed out that out of 84 officers, 29 may now practically be regarded as absentees owing to furlough, vacancies, &c., a reduction which certainly seems abnormally large. It is further suggested "what may in addition be expected should there occur any serious outbreak of illness among the officers left ; working as they do, under conditions of severe exposure, liable in their journeyings on duty to come into contact with disease-infected populations?" These latter misgivings are, we think, a little far fetched, and, as is often the case, may be carried to an absurdity. As in the case of life insurance the whole matter depends upon the law of probabilities, the numerical values for the calculation of which are taken from observed facts. No one would think of increasing the premiums beyond the calculated values in order to allow for what *might* happen when there are no precedents to indicate that the *might* should have an existence.

Dundee Electric Lighting.—Contracts for the Works Accepted.—A meeting of the Dundee Gas Commision was held last Friday for the purpose of accepting contracts for the installation of electric lighting about to be introduced into the city. Tenders for the contracts in connection with the buildings of the electric lighting station to the extent of £3,112 10s., and in connection with the electric works amounting to £17,330, were authorised to be accepted. As the successful contractors for the electrical department have not had an opportunity of replying, their names are meantime withheld by the committee. The price proposed to be charged is 6d. per unit, or about equal to ⅜ths of a penny per lamp per hour.

The Mansion House Electric Lighting.—The Court of Common Council have given authority for spending the sum of £210 in lighting by electricity the windows of the Egyptian Hall at the Mansion House.

Transmission of Power by Electricity.—An alumnus of the School of Mines of Columbia College, U.S.A., has offered a prize of £20 for the best essay on "The Transmission of Power by Electricity," sent in by a graduate of the school. The essays are to reach Prof. W. P. Trowbridge by November 1st next.

The Austrian Telegraphs.—A Vienna correspondent of the *Financial Times* says that, according to a statement just published, the receipts of the State Telegraph during the first five months show a decrease of 8 per cent., as compared with the corresponding period in 1891. The difference is due to the new scale of rates. The Government intends to sell the Vienna telegraph net to a private company. Negotiations have already been set on foot to that effect.

Westinghouse Electric Company's Annual Meeting.—The annual meeting of this company was held on May 18th. This was the first important meeting since the company's re-organisation. The old board of directors was elected with the exception of N. W. Bumstead who succeeds Charles Fairchild. The report stated that under the plan of re-organisation the company has acquired (in addition to the shares previously held) all but 634 shares of the capital stock of the Consolidated Electric Light Company. From January 1st, 1891, to March 1st, 1892, the company's sales, including those of its leased companies, aggregated $3,468,900.50. The impetus given to the business by the re-organisation is shown by the fact that the orders taken by the company during the two months of March and April of this year aggregate $1,576,235.83, and the prospects for a large business were never better than now. The general tone of the report throughout speaks largely of the prosperous condition of the company.

Wire Tappers.—A perfectly organised gang of wire tappers is operating from this town, says the New York *Sun*. "It consists of about 25 dishonest telegraph operators and as many more dishonest linemen, who tap pool room wires over which the returns of the horse races are sent and defraud bookmakers. They are not amenable to any law, and they know it. Therefore, they drift about the country, tapping wires promiscuously, and making a good living without doing much work. Some are stationed permanently in New York, and they devote their entire attention to the pool rooms of this city. The leader of the gang has his headquarters here and directs his confederates from here. He is well known by the telegraph companies, and is one of the most expert telegraphers in the business. The ingenuity of the gang just at present is startling. A week or so ago the gang attempted to tap the wire of a well known bookmaker here. The lineman went to the building in which the pool room is, and inquiring for the janitor told him that he had come to repair the wires of the bookmaker. The janitor unlocked the door of the pool room, as it was long after hours, and the lineman deliberately cut the insulated wires which entered the window and ran to the operator's table and carried them out again on a loop of very fine wire. On the following day the discovery that the wire had been tapped was made in a peculiar manner. The sunlight streaming through the window struck the shiny copper wire where the insulation had been cut to make the connection, and the reflection caused the operator who saw it to become suspicious and to make an investigation. The wire tappers had not made an office connection and were not caught. The telegraph company thought they would be protected partly when they put their wires underground, but they have been disappointed at times. The tappers have tapped a number of wires that run from the telegraph office to the bookmakers' places by entering the buildings in the cellars and running up elevator or light shafts. The tappers traced the wires into the cellar, tapped them, and carried them to another room in the same building or to a room in a building adjoining." With reference to the foregoing we may add that one method of preventing tapping is to duplex the circuits; a repeater would then be necessary before signals could be read at any intermediate point.

Electric Launches on the Manchester Ship Canal.—A station has been established at Eastham to supply current to the electric launches plying on the Manchester Ship Canal, and is now working satisfactorily.

Oxford Electric Lighting.—The *Financial Times* states that the mains have now been laid throughout the compulsory area at Oxford, and the generating station at Osney, on the banks of the Thames, has been constructed and equipped. The Oxford Electric Company expects to turn on the lights and get to work by June 18th, the day before Commemoration. The company will be able to supply at first as many as 15,000 lights, and several electrical firms in the town are busy obtaining orders for wiring and fittings. During Commemoration week various entertainments at Magdalen College and the Corn Exchange will be lit by electricity. The Oxford Corporation has granted permission for the erection of arc lamps of 3,000 candle-power each near the Great Western and London and North-Western Stations, also in Cornmarket Street, Broad Street, and High Street.

The Scientific Spirit—Old and New.—The following letter appeared in *Industries* last week from a correspondent signing himself "W. M. M.," and as it so entirely coincides with our views, we reproduce it in full:—"About two hundred years ago a young man, whose name is still held of some account, was engaged in the work of verifying by calculation a theory of his own respecting the curve of the moon's motion in its orbit. There was a discrepancy of 14 or 15 per cent. between the observed and calculated results, and consequently he laid aside at that time any further consideration of the matter. On Friday last the members of the Physical Society assembled in force to hear another young man, whose name is now held of some account, give a statement of the evidence for and against the theory that the earth carries the ether with it in its motion round the sun. The lecture was illustrated with many diagrams of experiments, mostly negative or inconclusive in their results. *Inter alia* there was a diagram of observed and calculated results showing a discrepancy of about 99 per cent. But science has advanced since Newton's time, and the last thing any modern scientific man would think of doing is to 'lay aside all further thought of this matter' on account of a trifling discrepancy of this sort. There is a good deal to be said for this modern view. Newton was right after all, and a too scrupulous delicacy might have caused him to miss his greatest discovery and the *kudos* attached to it. Adams first calculated the position of Neptune, but Le Verrier published first, and your modern man does not mean to be caught napping so, even if he has to publish before finishing his calculation. Does not Mayer share with Joule in the opinion of half the world the credit of the theory of the conservation of energy, and who would have heard of him if he had stopped to verify? We are even told that it is little short of a crime to 'hide the light that is in us,' no matter how feeble and flickering it may be, lest haply someone greater should waste his strength collecting and arranging the uncompleted work, as Maxwell did for Cavendish. And yet—and yet—the *Principia* will endure for all time: will 'Modern Views of Electricity,' with its choice of inconsistent hypotheses, or 'Electromagnetic Theory,' with its *rational* (?) system of units, its uncouth phraseology, and its petulent contempt for whatever is not brand new, stand such a test? A bigot for classical education, with an insufficient appreciation of Newton's genius, attributes his superiority in part to the fact that he published in Latin. 'You may think any scientific nonsense you please,' says this misguided person, 'and you may write it down readily enough in English, but you can't put it into Latin, nor, easily, into French. If it goes readily into German, it is probably more scientific and worse nonsense than usual.' But that, of course, is absurd. In these days it is often almost as good a deed to kill a false hypothesis as to establish a true one; and for this purpose the publication of negative results is most useful, nor is it contrary to precedent. Kepler gave his failures to the world, but only after he had arrived at the truth; Faraday gives his negative results, but he draws the logical inference from them. In each case we could ill spare the insight obtained into the mind and method of a genius. A reasonable rule might be laid down that only those who succeed are entitled to show where they have failed; but then how meagre would be the reports of our scientific societies!"

The American Institute of Electrical Engineers.—The first annual dinner of this institute was held on May 17th. In the course of the after-dinner speeches, Prof. Geo. Forbes, of London, paid compliments to the enterprise of his American co-workers. "The professor," says the *Electrical Age*, "always sees much to admire every time he comes to America, particularly in electrical development, and he is afraid that his English brethren will question his loyalty to the British crown when he relates to them the wonderful advances made in America. It was, indeed, pleasant to listen to the sincere utterances of the professor regarding the position America occupies in reference to electrical progress, particularly in the electric railway line; and he was forced to admit that England would be far better off if her people had a part of the spirit of enterprise possessed by Americans.

From other sources we learn that since his arrival in New York he has found his time very fully occupied, the opportunity having been seized by several capitalists and others to consult him with regard to proposed new enterprises. He has recently visited Niagara Falls at the request of the Cataract Construction Company, for whom he is acting in the capacity of consulting engineer in their enormous power transmission project, and has, it is understood, been retained also by the Calumet and Hecla Mining Company as consulting engineer for their proposed utilisation of about 2,000 H.P. in a transmission of several miles in their mines, for the various purposes of ventilation, pumping, drills, haulage, lighting, &c. These and other engagements are expected to detain Prof. Forbes longer in America than he had at first intended to stop on this trip.

Bury Town Council and Electric Lighting.—At the monthly meeting of the Bury Town Council in connection with the scheme of electric lighting for the borough, it was reported that a site had been secured at Whitehead Bridge as the central supply station, and it was stated that the plans would shortly be laid before the council.

Institution of Electrical Engineers' Conversazione.—Invitations are being sent out to the members of the Institution, by Prof. and Mrs. Ayrton, for a conversazione in the galleries of the Royal Institute of Painters in Water Colours, 191, Piccadilly, on Friday evening, July 1st, from 9 to 12 o'clock.

Manchester Technical Scholarships.—At a monthly meeting of the Manchester City Council, it was stated that during the last month one-half of the profits of the Royal Jubilee Exhibition of 1887 had been handed over to the Corporation under the agreement with the Whitworth trustees. There was an item in the proceedings recommending that a grant of £350 be made for additional requirements in the electrical engineering department, and that a man be engaged at a salary of not more than £3 a week to make physical and electrical apparatus.

Obituary.—Mr. James Radcliffe, late telegraph superintendent to the Great Northern Railway Company, died at his residence, Ordsall House, Retford, Notts, on the 2nd inst., after a few days illness following an attack of paralysis on the 28th ult. Mr. Radcliffe was born in 1828, and entered the service of the Electric Telegraph Company in 1848 at Manchester. He was subsequently clerk in charge at Plymouth, and afterwards superintendent of the South Wales district in the service of the Electric Company, which he quitted in 1859 to join the Magnetic Telegraph Company, in whose service he was superintendent of the Birmingham and South Wales district up to the transfer of the telegraphs to the State in 1870. In the latter year he became telegraph superintendent to the Great Northern Railway Company, remaining in that capacity until his death. Mr. Radcliffe was widely known and highly respected in the electrical world, being one of the original members of the Society of Telegraph Engineers, now the Institution of Electrical Engineers, with which he was connected up to the last. He was the patentee of a number of electrical appliances, including block and interlocking instruments and electric lighting apparatus for trains, and may be said to have been one of the pioneers of that method of train lighting. The interment took place at Ordsall, near Retford, on the 6th inst.

Award.—The first award of the Salomons scholarship value £35, has been made to C. H. C. Woodhouse, second year matriculated student in the Department of Electrical Engineering of the City and Guilds Central Institution, associate of the Royal College of Science, B.Sc. London University.

The New Telephone Company's Bill.—We hear that the Bill promoted by the New Telephone Company providing for the dissolution of the existing company and for its re-incorporation with enlarged powers has been definitely withdrawn by the promoters for the present session.

Illumination of Buda-Pesth Streets by Electricity.—On Tuesday last, which was the eve of the 25th anniversary of the Coronation day, every town in Hungary was the scene of illuminations and public rejoicings. Notwithstanding the pouring rain, the illuminations in Buda-Pesth and Vienna, says the *Standard* correspondent, was the grandest ever seen there, the leading feature being the electric light, which has probably never before been anywhere employed so lavishly.

Visit to Messrs. W. T. Goolden & Co.'s Works.—On Saturday last the Federated Institute of Mining Engineers paid a visit to the works of Messrs. W. T. Goolden & Co., with a view of seeing the electric machinery connected with the application of electricity to mining. Among other objects of interest, the party inspected the following:—A pumping plant, consisting of a 15 H.P. "Goolden" mining dynamo; a three-throw ram pump with 5½-inch plungers, 9-inch stroke, driven by a "Goolden" mining motor; starting and regulating gear; a coal-cutting plant, including a 50 H.P. dynamo coal-cutting machine, gateway switches, terminal boxes, portable cable drums, &c., and an 80 H.P. mining dynamo, part of a plant for driving two pumps: one capable of dealing with 400 gallons per minute, on a 450 feet lift, and driving also a colliery ventilating fan; an electric lighting plant, consisting of an 80 H.P. direct driven "Goolden-Willan's set;" a complete drilling plant for the Ironstone mines of Messrs. Bell Bros., Middlesborough (in construction); and parts of the plant the firm is now constructing for Messrs. John Watson & Co., of Earnock, comprising two hauling engines, two lighting dynamos, power dynamos, driven by "Westinghouse" engines, with a total of 120 B.H.P. In the instrument factory the party inspected the latest patterns of instruments now being made, including "Eversheds" patent shielded voltmeter, which can be used in central stations close to the dynamo without being affected. A good deal of the plant enumerated was shown in actual operation, and the party left expressing great satisfaction with all they had seen.

Electrical Engineer Drowned.—A sad bathing fatality happened at Cookham on Wednesday morning. A young electrical engineer, named Joseph Giles, aged eighteen, of Seymour Square, proceeded up the river for a day's outing. At Odney Pool, adjoining the Thames, where many fatal bathing accidents have occurred, Mr. Giles dived off a board. He rose to the surface, but sank again, and was not seen afterwards.

NEW COMPANY REGISTERED.

London Electric Wire Company, Limited.—Capital, £50,000 in £5 shares. Objects: To acquire, take over as a going concern, and carry on the business of manufacturers of electric wire, telegraph, and telephone appliances and other apparatus carried on by Thomas Willey and John Willey under the title of "The London Electric Wire Company" at Playhouse Yard, Golden Lane, London, E.C. Signatories (with 1 share each): Thomas Willey, Bonchurch, Molyneux Park, Tunbridge Wells; John Willey, Craven Park, Willesden, N.W.; F. J. Lamb, Cotswold, Fairholt Road, Stoke Newington; W. H. Willey, Anchor Works, Playhouse Yard, Golden Lane, E.C.; A. L. Don, 2, Hillside, Stonebridge, Willesden; J. A. Hodgson, Anchor Works; H. Capel, Anchor Works. The number of directors is not to

be more than five, the first being Thomas and John Willey, and each of these shall hold office for life or until resignation. Qualification, 200 shares; remuneration, five guineas for each meeting attended. Registered on the 31st ult. by Wilkens, Blyth, Dutton and Hartley, 112, Gresham House, Old Broad Street, E.C. Registered office, Anchor Works, &c.

BUSINESS NOTICES, &c.

Lighting Omnibuses by Electricity.—Since the introduction of Electric Lighting, efforts have been made to obtain a satisfactory arrangement for the lighting of omnibuses, the present system being felt to be far from satisfactory; the Lithanode and General Electric Company, at the suggestion of Messrs. Willing, have recently constructed an improved and lighter form of battery than was hitherto obtainable, and for the past three months the apparatus has been regularly used on an experimental scale in certain omnibuses. So much satisfaction has been given to all concerned that orders have now been received by the Company to light up a number of vehicles with the apparatus, the light, in the first place, being installed in the Road-Car Company's omnibuses. The improved apparatus consists of a small five-cell battery, weighing about 15 lb., and mounted in a stout wooden box. This battery is capable of discharging at the rate of one ampère, and at an E.M.F. of 10 volts for a period of from 15 to 20 hours. The recharging is very simple, and can be effected in about six hours. On the outside of the wood containing-box are two brass plates, which constitute the battery terminals. A light wooden box of somewhat larger dimensions is fixed under the driver's box, and into this the battery is lowered. Two springs fixed inside the last-named case are made to engage the two contact plates and the battery, and these serve to establish contact between the lamp and battery. By this method no loose terminals or connectors of any kind are employed, and all danger from defective or imperfect contacts is obviated. The light-giving apparatus consists of a 5-C.P. Edison-Swan lamp with a bayonet-jointed shoe terminal, and backed by a white reflector. Wires from the lamp lead down to the outer containing box, and then through the spring terminals to the battery. A novel form of switch is placed behind the lamp bezel, and by its means the 'bus conductor can throw the lamp in or out of action. This operation is effected by simply giving the lamp dome a slight turn. All wires connecting the battery and lamp are securely fixed within a wood casing, so that damage to any part of the apparatus is next to impossible. The element in the battery cells is of the latest type of lithanode, and special precautions are taken to prevent damage either by jolting or rough handling. The batteries can be reinstated in a few seconds, as the operation merely consists in removing the exhausted battery and dropping in a new-charged one. The spring terminal already described automatically establishes contact between the lamp circuit and the battery. The Lithanode and General Electric Company have entered into a contract with Messrs. Willing for both the electrical and mechanical maintenance of their batteries. The whole of the arrangements for the improved light have been worked out jointly by the Lithanode Company and Mr. Hymns, of Messrs. Willing's.

Woodhouse & Rawson United v. W. S. Sargeant.—In the County Court on Friday last week, Messrs. Woodhouse and Rawson, electrical engineers, of Chiswick, sued Mr. W. S. Sargeant, of the same place, for £5 10s. 10d., for repairs to a smoke box belonging to a steam launch. Mr. Hicks, solicitor, appeared for the plaintiffs, and Mr. Robinson for the defendant. Mr. Hicks explained that the defendant had given orders for the work to be done, and two men had been sent, and their time on the job was 39 hours each. This at 1s. 3d. and 9d. an hour respectively, together with £1 12s. 10d. for materials, made up the claim. Defendant had paid £2 10s. into court. Mr. Masterman, plaintiffs' manager, gave evidence, and in cross-examination said he had inspected the work while in progress and afterwards, but could not say whether it was on the foreshore or on a float, or barge, or on the launch. Mr. Robinson stated that defendant had been grossly overcharged, and that in consequence of the men idling their time over the fire and leaving their work, he had refused to allow them to finish, after frequent complaint of their conduct. The whole job, including materials, should not have cost more than 35s., and as £2 10s. had been offered this should have been accepted. He called the defendant, Mr. Carpenter, Mr. Cloud, and Mr. George Knowling in support of his contention, and thereupon His Honour gave judgment for the defendant, with costs.

The Electric Light in the West End.—A fair amount of installation work is at present being carried on in the West End. The Electrical Supplies and Fittings Company, Limited, of Charing Cross Road, W.C., are engaged in putting in an installation at 8, Adelphi Terrace, Adelphi, W.C.—The new Trafalgar Square Theatre in St. Martin's Lane, W.C., which is now approaching completion, has been fitted throughout with the electric light by Messrs. Vaughan & Brown, of Kirby Street, E.C.—Some new premises in Charing Cross Road known as the Cecil House Chambers, are at present being wired for electric lighting. The work is being carried out by Messrs. D. Hulett & Co., Limited, of High Holborn, W.C.—Messrs. E. L. Berry, Harrison & Co., of Lyric Chambers, Whitcomb Street, W.C., are fitting up an installation at 4, Sackville Street, Piccadilly, W.—Messrs. John Pound & Co. are engaged in fitting up an installation at their branch establishment at 38A, New Bond Street, W.—Messrs. Rashleigh Phipps and Dawson, of Berners Street, W., are fitting up an installation at 38, New Bond Street, W.—The premises known as the Pantheon, of Messrs. W. and A. Gilbey, in Oxford Street, are being fitted with an installation by Messrs. Pritchett Brothers, of Soho Square, W., and Messrs. Meteyard and Haine, of Archer Street, Bayswater, are fitting up an installation at 117, Oxford Street.

Hotel Electric Lighting.—The introduction of the electric light into Harlesden has caused no small stir in the neighbourhood, and has doubtless been accentuated by the controversy with the gas company with respect to the increased charges made by them. The illuminant has been placed in the new premises of the Royal Oak Hotel, standing in the Harrow Road. Messrs. Joel and Company have fitted up the installation with great success. The electric light is supplied throughout the entire premises. In the bar there are two Pilsen-Joel arc lamps of 2,000 C.P. each, and outside in the street will be fixed three 100 C.P. incandescents. Altogether, there will be 120 16-C.P. incandescents fixed in the building. The fittings have been designed by the architects (Messrs. Tinker and Morewood, of Southampton Row); those to be placed in the bar will be of most tasteful design. We understand that the owners, in addition to their own establishment, will supply the electric light to a few shops in the neighbourhood.

The Electric Light in St. Pancras.—The adoption of electric lighting in this district, which since the opening of the central station by the vestry has been most rapid, still continues. The British Electric Lighting Company, Limited, of 11, Delahay Street, Westminster, has secured the contract for the electric lighting of the new premises and workshops in Tottenham Court Road, now in course of construction for the Association for Promoting the General Welfare of the Blind.—The clothing establishment of Messrs. J. Hepworth and Sons, situate at 113, Tottenham Court Road, is being installed by the Electric Power and Traction Company, Limited, of Kentish Town.—The premises of the Arcadia Floral Company, and the Court Toilet Club, also in Tottenham Court Road, have been recently fitted with the electric light by Mr. A. G. Shearer, of Kentish Town. The electrical department of Messrs. Maple & Co., Limited, are fitting up an installation in their Cabinet Works, in Euston Road.

Electric Lighting of the Kimberley Exhibition.—The South African and International Exhibition, which is to be opened at Kimberley in September, is to be lighted entirely with the electric light. For the extensive grounds of the Exhibition, and interior of some of the principal buildings, arc lamps are to be used. These will be worked from three "Manchester" dynamos, each for an output of 900 volts, 10 ampères. The total number of arc lamps to be used is 37, each of 2,000 candle-power. The interior of the smaller buildings will be lighted with incandescent lamps of 16 candle-power, worked from three "Manchester" dynamos, each for an output of 110 volts, 120 ampères. The whole of the plant, both for the arc lighting and incandescent lighting, is being supplied by Messrs. Mather & Platt, Limited, of the Salford Iron Works, Manchester.

The Commercial Cable Company.—This enterprising company have recently had an extensive electric light plant put down at their Waterville Station, County Kerry. The installation, which has been carried out by Mr. J. A. McMullen, consists of a 9 H.P. Priestman petroleum engine, driving a dynamo on the Scott-Sisling principle, with two windings on the armature, one supplying current at 100 volts for direct lighting and the other 125 volts for charging accumulators. There is also a large battery of 53, 23L, E.P.S. cells. The buildings are wired for 80 16-C.P. lamps. No pains have been spared to make the installation a most complete one in all respects. The great benefits of the light are already much appreciated by the *employés* of the company The electric light was installed at this company's Canso, Nova Scotia Station, some time ago.

Electric Launches.—Mr. Sargeant, of Strand-on-the-Green, Chiswick, is now laying down at the new electric launch works, Eel Pie Island, Twickenham, an electrically-propelled gig, carved, built in cedar. The boat is designed to give a mean speed of 6½ to 7 miles an hour, with one charge of about 5 to 7 hours' duration; she will be fitted with an awning, cushions, electric light, electric bell, forward. The accumulators being sealed and placed below the water line forms ballast, and gives great stability for sailing, therefore this boat can be rowed, sailed, or electrically propelled at pleasure. The vessel is being built to the order of Mr. F. W. Haselman, of Granby Street, N.W., and will conveniently accommodate six passengers. This class of electric launch can be produced for under £100, and they are very useful little boats for the Upper Thames and canals.

The Lighting of the Chicago Exhibition.—The following letter has been sent to us by the London office of the Westinghouse Electric Company, Limited:—"We have received a communication from the vice-president and general manager of the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., U.S.A., to the effect that that company has, after severe competition, been awarded the contract for the incandescent lighting of the World's Columbian Exhibition to be held at Chicago, 1893. We understand that the contract covers apparatus to the extent of about 90,000 16-C.P. lamps capacity."

The Johnstone System of Electrical Underground Conduits.—The International Electric Subway Company, Limited, have lately published in pamphlet form some of the opinions of American experts and electrical engineers on the Johnstone system of electrical underground conduits, which were recently described and illustrated in the ELECTRICAL REVIEW. The opinions given should certainly have great weight, as they are by men who appear to be well-versed in regard to underground work. They show what is thought of the Johnstone system in America, where it has been well tried.

Electricity in Country Mansions.—The *Glasgow Evening Times*, commenting under this heading, on the lighting of country mansions by electricity, refers to the comparative costs of obtaining the power by gas engines or by water. The latter our contemporary considers the most economical source, and proceeds to congratulate Mr. Fulton, of Broadlie, Dalry, for having led the way in Ayrshire in this respect. This gentleman has recently fitted up his residence with the electric light, and he utilises a small stream, which runs through his grounds, for the motive power. The installation was carried out by Messrs. Robertson & Co., electrical engineers, of Paisley.

New Businesses.—Mr. Leoline A. Edwards, formerly of the Brush and Electric Construction Companies, informs us that he has opened an office at 19, Laurence Pountney Lane, Cannon Street, E.C., where he will carry on the business of a mechanical and electrical engineer.

Messrs. New and Mayne have commenced operations as electrical and general engineers, with offices at Palace Chambers, Westminster, S.W., and works at Woking, Surrey. They were formerly with Messrs. Gill, of Parliament Street.

Cox-Walker.—We have received from Messrs. Cox-Walkers, of Darlington, copies of some new "handy" lists of telephones which they have recently got up. On one of the lists, titled "Telephonic Progress," it is stated that the firm are under arrangement with the National Telephone Company, for manufacturing and selling Hunning's transmitters (in improved forms), and Cox-Walker magnetic telephones.

Mining and General Electric Lamp Company, Limited.—From our "City Notes" columns it will be seen that the above company is to be wound up, as by reason of its liabilities, it cannot continue its business.

Paterson and Cooper.—Mr. W. B. Esson has resigned his post at Messrs. Paterson and Cooper's, which he vacates at the end of the present month. Mr. Esson has filled the positions of manager and electrical engineer to the firm for nearly nine years.

Tenders Wanted—Denmark.—Tenders are being invited by the director of telegraphs in Jutland and Fionie, at Aarhus, for supplying about 31 tons of iron telegraph wire.

CITY NOTES.

Elmore's German and Austro-Hungarian Metal Company.

THE directors, in submitting the accounts for fifteen months ending 31st December, 1891, explain that the audit of these accounts has been delayed because the principal vouchers for expenditure have been in the hands of Government officials in Germany since October last, and have only recently been returned by them. At the first general meeting it was stated that the directors were then negotiating for the purchase of land, buildings and water power in Germany. This negotiation was completed on May 4th, 1891. On acquiring this property the directors completed the building according to the special requirements of the Elmore copper depositing process, a considerable part of the cost of the completion being defrayed by the original owner; and they have fitted up one floor of the main building with powerful dynamos, and all the necessary machinery, tanks and apparatus for the manufacture of seamless copper tubes up to an output of 16 to 20 tons per month. They have installed the electric light; they have also fitted up a workshop with lathes and other tools, a forge, and a room with a powerful testing machine for proving tubes. They have also erected a furnace, accommodation for workmen and offices. A house for the works manager is in course of erection. The original purchase included two turbines and gearing for utilising the water power up to 550 horse-power, which, with a small auxiliary steam power for a limited portion of the year, will be sufficient to work the whole factory when fitted hereafter with tanks to its full capacity for an output of about 80 tons per month. The price at which the lands, buildings and water power have been purchased is £22,000. The directors feel considerable satisfaction in stating that these properties have since been valued in detail by an official valuer, appointed by the German Government, at the total sum of 873,222 marks, equal to £43,661. In addition to this there had been expended upon machinery at the same date the sum of £6,610, making the total value, as to the larger part officially ascertained, £50,271. As it was found that difficulties existed in obtaining legal possession of real property in Germany by a foreign company, the directors finding that a German company could be formed in which the entire capital might be held by Elmore's German and Austro-Hungarian Metal Company, and the management retained by that company's board, the individual directors becoming the Board of Management and the Board of Supervision required by German company law, decided to form such a company. On October 7th, the board attended at Cologne, and having completed all the necessary documents in conformity with German law, established a company under the title of "Elmore's Metall Actiengesellschaft," with a nominal capital of 1,000,000 marks, equal to £50,000, and with its domicile at Cologne. In this company the entire capital is held by Elmore's German and Austro-Hungarian Metal Company, Limited, and its nominees, and the management is entirely in the hands of the directors. The directors have not allowed the delay in completing the legal forms to interefere with their operations, but under the management of the energetic and able works manager, Mr. Preschlin, pressed on their works at Schladern without intermission, and have satisfaction of now informing the shareholders that the manufacture of tubes and the coating of calico printers' rollers with copper has been commenced, and the first delivery of goods has been made, permission to trade being included in the concession for working which was granted to the company on the 26th ult. Orders are freely coming in through the agency which has been established at Cologne, and the directors believe that in a few weeks, when the plant has been fully equipped with mandrels, the delivery of which has been much delayed by the manufacturers, the factory will be fully at work, and have more orders than it can execute. In this belief the board has prepared an estimate for increasing the plant to double the present output. The additional machinery and plant will cost about £2,500. With regard to Austria-Hungary, the board has taken all necessary steps for formally working the several patents in those countries in accordance with the local patent regulations, under the superintendence of their representative at Vienna, Dr. J. de Griez, who is also in negotiation with an eminent firm of metal workers for working the Elmore patents under license from this company. The working capital at the disposal of the board is not at present sufficient for working on an extended scale both in Germany and in Austria-Hungary, but meanwhile the board is in possession of information as to suitable locality, cost of land, &c., which will enable them to proceed to the erection of works when sufficient capital may be available. With reference to finance, the directors have thought it desirable in the interests of the company to take steps with the view of relieving the pressure on its funds caused by the existing debenture stock, feeling that until profits are earned the interest amounting to £3,000 per annum and the liability there exists of repaying the capital sum by instalments during the next five years is a heavy charge upon the working capital. The result of negotiations is a proposal provisionally accepted by the principal holders of the debenture stock, by which the £50,000 of 6 per cent. debenture stock will be redeemed, and replaced by fully paid 7 per cent. preference shares; such shares to be entitled to further dividends *pro rata* after the ordinary shares shall have received dividends of 10 per cent. per annum. In order to enable the board to accomplish this redemption of debentures, consent will be asked at the general meeting to the issue of preference shares to be exchanged for debentures. This will be in form an increase of capital, though not so in substance, because the existing debenture capital will be replaced by share capital. At the same time sanction will be asked to the issue of the 25,000 shares of the original issue, at present unallotted, either wholly or in part as preference shares, at the discretion of the directors as to the time and manner of issue, for the purpose of providing additional working capital as may be required.

The first annual meeting of this Company was held at the Cannon Street Hotel, yesterday, Mr. JAMES ROCK presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN took the report as read. He said that he and his colleagues had for many weeks past been anxious to meet the shareholders, but they had been unable to make up their accounts because they had not received vouchers from the official auditor in Germany. As mentioned in the report, they had completed their factory in Germany and it was now actually at work. One storey of the building was filled with machinery and tanks for depositing copper in the form of tubes. The position of the factory was good, and they had secured some very valuable privileges. With regard to the profits which they hoped to make, on the average price of a shilling per pound, they hoped to realise a profit of £30 a ton, and when they got up to 20 tons per week they would receive £30,000 a year. Of course, they would have to extend their works, for at present they were only prepared to turn out 5 tons per week, but they could increase this output to 10 tons per week with an expenditure of £2,000. Coming now to the question of finance, it must not be understood that they were increasing their capital; they were only converting £50,000 debentures into preference shares. He (the speaker) thought it showed great confidence on the part of the debenture holders to take equal risk with themselves. After some discussion the chairman moved the adoption of the report and accounts, which was carried.

The following resolutions were then proposed:—

1. "That the capital of the company be increased to £50,000 by the creation of 25,000 new shares of £2 each."

2. "That such new shares, and the 25,000 shares now unissued of the original capital of the company, shall be called 'preference shares,' and shall be entitled, out of the profits available for distribution in each year, to a preferential dividend of 7 per cent., and also to participate *pari passu* with the holders of the existing issued shares of the company in the surplus profits of each year, after a dividend of 10 per cent. has been paid for such year on such existing issued shares of the company, which shall in future be called 'ordinary shares.'"

After a little further discussion these resolutions were adopted.

The Consolidated Telephone Construction and Maintenance Company, Limited.

THE director's report states that the operations of the company for the year ending March 31st, 1892, show a net profit of £7,188 4s. 8d. which, with the amount carried forward from last year, leaves a balance of £8,904 9s. 6d. for disposal, after making provision for doubtful debts. The directors propose to deal with the amount available as follows, viz.: to pay a further dividend of £1 per cent.

for the half year on the ordinary shares, and £3 per cent. on the preference shares for the half year, making, with the interim dividend paid in November last, £6 per cent. for the year on the preference shares and £3 10s. for the year on the ordinary shares; writing off the sum of £617 4s. 10d. for depreciation of plant, machinery and furniture; also £63 16s. 8d. from cost of new building; thus leaving a balance of £1,366 7s. 9d. to carry forward. It is with regret that the board find the figures for the year are not so satisfactory as on previous occasions. The falling off in the profit in manufacturing is owing to American, French and German competition, the prices of our manufactures having had to be reduced to meet the demand for cheap goods, while the heavy duties placed on our instruments abroad, have no doubt tended to reduce our sales in that direction. Every effort is being made to reduce the expenditure, both in the manufacturing department and in the office expenses. It will be seen that certain items of expenditure, are charges on the present occasion, which will not recur. On the result of the accounts being known, your directors unanimously resolved to relinquish half of their fees for the year ending March 31st, 1892. Agencies for the sale of your manufactures have been established throughout the United Kingdom. The company has also an exhibit of its manufactures at the Crystal Palace Electrical Exhibition, which is attracting a considerable amount of attention. The directors are now engaged in organising a private wire telephone rental business. This fresh source of revenue will, they hope, be of a lasting nature. The subsidiary companies continue to make progress, as is shown by the following statement:—

	Year ending March 31st.					
	Paying subscribers.		Rental.		Increase.	
	1891.	1892.	1891.	1892.	Subscribers.	Rental.
Telephone Company of Austria	3,263	3,588	£20,500	£22,500	325	£2,000
Anglo-Portuguese Telephone Co.	2,074	2,139	£13,458	£13,640	65	£182
Total increase for the year ...					390	£2,182

The Austrian Government have signed a contract with the Telephone Company of Austria for the purchase of that company's exchange business, to take effect from January 1st, 1893. The result to your company will be the receipt of a large amount in repayment in respect of the securities we hold in that company. In accordance with the articles of association, the following directors retire by rotation, and being eligible, offer themselves for re-election, viz., J. H. Buckingham, Esq., and Richard Van Zeller, Esq. The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths, & Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election.

The meeting of the shareholders was held yesterday, Mr. C. L. W. Fitzgerald presiding.

The SECRETARY (Mr. Charles Curtoys), having read the notice convening the meeting,

The CHAIRMAN, after referring to the figures in the report, said that it was with extreme regret the directors were obliged to present accounts which were not so favourable as on past occasions. Before explaining how this state of affairs was brought about, he called their attention to several items on the debit side of the account which would not appear again next year, for instance: Colonel Gouraud, £550; Crystal Palace Exhibition, £174. There had also been considerable extra expenditure in advertising, stationery, and also in the establishment of agencies. All of these items which came to a considerable sum, would be saved next year. The profit on manufacturing was this year £6,665, as compared with £9,619 last year, and which had averaged from £8,000 to £9,000 generally since 1885. Last year the National Telephone Company's patents expired; that was one cause of the diminution in profits, and secondly the United Kingdon became free ground for anyone to compete for telephonic business, and foreign firms were not slow to take advantage of the fresh market, and a number of them started agencies in London and elsewhere, and hosts of English firms started making telephones. Their directors had always striven to manufacture a thorough good, highly finished instrument at a substantial yet not exorbitant price. They found that their new competitors were offering telephones at cheaper prices than they were themselves selling at, and there was no alternative for them but to reduce their prices also, and that state of affairs had gone on for the last six months. Unfortunately for them their competitors offered telephones at about 20s. to 30s. and of course they were asked to supply at about the same price. They did not therefore sell so many of their high class instruments, but got orders for a lower class of instrument which yielded a lower profit. Then again, many foreign nations had lately put very heavy duties on goods sent to their countries and that had had a detrimental effect upon the company's business. That was how they accounted for the falling off in their profits. They had further established agencies throughout the United Kingdom and they were now organising a telephonic rental business for private lines such as from house-to-house and shop-to-factory, and so on. They hoped that that business might prove of a lasting nature, and he believed it would be so in spite of the enormous competition which was going on for that class of business. It would not be for want of trying that they would not succeed in getting it. After some further remarks regarding the measures taken for meeting the competition, and regarding the purchase of the Telephone Company of Austria by the Austrian Government, who were to pay over to the directors of that company the sum for purchasing the first fortnight in 1893, he moved the resolution that the report and accounts be adopted, and the dividends as stated in the report be declared.

This was seconded by Sir Alexander Armstrong, K.C.B., and, after some discussion, was carried unanimously.

The retiring directors (Mr. J. H. Buckingham and Mr. Richard Van Zeller), and the auditors (Messrs. J. D. Griffiths and F. A. Green), having been re-elected, a vote of thanks to the chairman and directors for their services, and also for relinquishing half of their fees, was accorded, and the proceedings terminated.

The Electric and General Investment Company, Limited.

THE directors' report submitted to the third ordinary general meeting held at Winchester House, Old Broad Street, yesterday, states that the profit and loss account for the year ended May 31st, 1892, shows a gross profit on the transactions of the year of £34,379 4s. 5d., and after deducting all standing charges there remains a net balance available for distribution of £28,863 12s. 11d. An interim dividend has already been paid on the ordinary shares for the first six months of the year at the rate of 20 per cent. per annum, and the directors now recommend the payment of a further dividend upon the ordinary shares at the rate of 30 per cent. per annum for the past six months, and a dividend on the founders' shares of £30 per share. This will leave a balance of £20,863 12s. 11d., which the directors recommend should be applied as follows: £20,000 to reserve; £726 0s. 1d. for writing off the preliminary expenses; £137 12s. 10d. balance to be carried forward in equal moieties on account of the ordinary shareholders and founders. The amended articles of association recommended by the directors have been adopted at two extraordinary general meetings of shareholders, and approved by the holders of the founders' shares, and have been registered as the articles of association of the company. The directors have appointed as managing director, Mr. Emile Garcke, M. Inst. E.E., formerly managing director of the Brush Electrical Engineering Company. The directors who retire this year are Mr. George Herring and Mr. B. H. Van Tromp, who, being duly eligible, offer themselves for re-election. The auditors, Messrs. Rait and Kearton, also retire, and offer themselves for re-election. It is proposed to make the dividends payable on June 15th.

At the meeting of the Company, the Duke of Marlborough presided.

The SECRETARY read the notice convening the meeting.

The CHAIRMAN said it was his duty to make a statement generally with regard to the prosperity and condition of the Company. It was always a very pleasant task for the chairman of a company, when the company was in a flourishing condition, and he was sure that no shareholder could be otherwise than convinced that their company was in an extremely flourishing condition. Speaking for himself he must disclaim really any active part in the prosperity which had fallen to their lot; it was really owing to the other directors and their large commercial experience and their personal ability that he took the chair under such favourable conditions. It was largely owing to the efforts of the individual members of the board that they had been able to carry out to a successful issue several important undertakings. They had the large sum available for distribution of £28,863. There was a great difference between the character of the investments which were selected for taking care of their capital. They had been very prudently selected. The directors had never gone into a question that they had not first of all studied. They had also looked at all the disadvantages as well as the advantages, and so far their judgment had been correct. The City of London Electric Lighting Company had been launched almost entirely by the Electric and General Trust. That was a very large enterprise, which promised to have a very great future. It had a monopoly of the lighting of the City for 40 years. They had an immense demand for the electric light. He thought that the consumption would be very large, and consequently he felt sure that the City of London Company would prove a great success to the investors in that stock. The next question was that of the Pioneer Telephone Company. He then referred to the action of the Government and the Post Office. The Pioneer Company would be the means of bringing out the New Telephone Company, and that company would establish a twin wire system of telephony first throughout the metropolis, and then throughout the large towns of England. It was after great discussion and considerable care that the directors embarked upon that enterprise, and he thought they might look forward to it being a very successful venture. The few enterprises they had floated had been successful ones, and it would be the business of the directors to see that all enterprises they were instrumental in bringing before the public should continue to prosper. After some further remarks, he moved the adoption of the report and accounts.

This was seconded, and carried unanimously.

The retiring directors (Mr. G. Herring and Mr. H. B. Van Tromp), also the auditors, were re-elected.

The Western Counties and South Wales Telephone Company, Limited.

THE directors' report for the year ending 31st December, 1891, presented to the shareholders on Wednesday last, June 8th, states that the capital expenditure for the year ending December 31st, 1891, was £20,956 14s. 3d., making a total of £185,366 6s. 5d. to date.

The gross revenue of the company for the year 1891 was £52,224 1s. 6d. against £46,860 15s. for the year ending 31st December, 1890. The amount of income carried forward to next year's revenue, as representing sums received in advance for periods extending beyond 31st December, 1891, is £15,548 7s. 11d., against £14,212 19s. 1d. brought in from the previous year. The whole of the company's plant has been fully maintained and, where required, renewed, out of revenue. The company have continued to substitute, at considerable expense a large amount of copper and bronze wire for iron, which has increased the efficiency and durability of the plant. The working expenses, including maintenance and all working charges for the year 1891, have been £16,685 10s. 10d. against £13,775 18s. 1d. for the year ending December 31st, 1890.

	£	s.	d.
Balance of nett revenue account	11,236	17	4
Dividend of 6 per cent. on the paid-up preference share capital for the year ending December 31st, 1891 ...	6,000	0	0
Balance for appropriation, as per statement at end of accounts	£5,236	17	4

The directors recommend that a dividend at the rate of 1 per cent. be paid for the year on the ordinary shares, absorbing £2,811 19s. 5d., leaving a balance of £2,424 17s. 11d., from which will have to be deducted the amount which may be voted for the director's fees for the year 1891. The number of subscribers to the exchange system and of private line renters has further increased, and the progress made during the year is considered to be satisfactory. The respective totals at the close of the years 1890 and 1891 were as follows:

	Exchange.	Private.	Total.
December 31st, 1891	3,268	803	4,071
December 31st, 1890	2,875	712	3,587
Increase in 1891 ...	393	91	484

Mileage of trunk and renters' wires:

Erected up to December 31st, 1891	5,753 miles.
" " December 31st, 1890	5,018 "
Increase representing new business during 1891	735 "

In addition to the above, 191 miles of wire have been renewed during the year. The company has increased its trunk system, so that on December 31st, 1891, it had 505 miles of trunk pole lines connecting towns with each other, carrying 2,383 miles of wire; against 470 miles of pole lines, carrying 2,182 miles of wire, at the corresponding date in the previous year.

It is within the knowledge of many shareholders that for some time past a gradual process of amalgamating the provincial telephone companies with the National Telephone Company, Limited, has been in operation. It has been felt by the directors that either an amalgamation must be effected between this company and the National Company, or additional capital must be raised to meet the requirements of its important district, comprising the western counties and South Wales, for which the approval of the National Company would be necessary. After much discussion, the former alternative has been adopted, and terms have been provisionally arranged for the consideration of the shareholders. A provisional agreement is now in course of preparation, which will be submitted to a special meeting of this company with as little delay as possible. As soon as the provisional agreement has been finally settled, full information of the terms of the proposed sale will be afforded to every shareholder by circular or otherwise. The directors have pleasure in acknowledging the continued uniform courtesy of the permanent officials of the Post Office department.

Mr. Mark Whitwill and Mr. Thomas Pole, directors, retire, the former by rotation and the latter by ballot, but are eligible for re-election.

Messrs. Hudson Smith, Briggs & Co. retire, but are eligible for re-election as auditors.

The meeting was held on Wednesday under the presidency of Mr. Charles Nash, chairman.

The SECRETARY (Mr. H. F. Lewis) read the notice convening the meeting, and the report was taken as read.

The CHAIRMAN, in moving the adoption of the report, said: I cannot help expressing, in the first place, a feeling of some regret at this being probably the last annual meeting of our company as an independent undertaking. The circumstances that have led to the negotiations with the National Company for a fusion of the two undertakings are referred to in the report. I do not intend to have much to say about figures, but there are two points which I wish to bring before your notice, showing the progress of the business of the company. In 1886 our subscribers were 1,318, and in 1891 they were 4,011; in 1886 our gross income was £15,406, and in 1891 it had reached £52,224, nearly three and a-half times as much as in 1886. But to accomplish this we had to spend up to 1886 £56,501, and up to 1891 £185,366, a little more than three and a-quarter times the amount expended up to 1886. That progress is still going on. We cannot stand still, for the use of the telephone is rapidly increasing in all directions. We have constant proposals coming before us for extensions in our large telephone territory, but more capital is required to enable us to avail ourselves of the openings. Our existing capital is exhausted; in fact, something like £14,000 has been spent out of revenue, and a further issue to enable us to go on and carry on our work can only be arranged for at a high rate of interest. And if we make that issue, it must be independent of our preference shares and our first and second debentures, while the National Company is in a position to raise money on better terms than we could hope to do. That is one reason why we think it desirable that arrangements should be made for the fusion of our company with the National Company. There is another reason for the proposal that united action in the telephone world is of great importance in meeting competition and in treating with the Post Office. The other English subsidiary companies have amalgamated with the National. First of all there was the old National United, then the Lancashire and Cheshire; then the Northern Company was purchased, and at a later period the South of England Company was bought up, and ours is the only one remaining outside, and it appears to us to be desirable that we should not remain in that position. So our reasons for recommending an amalgamation are that the National Company is able and willing to carry out the extensions that we are not able to carry out now, and we are favoured here to-day with the presence of Colonel Jackson, the vice-president of the National Company, and Mr. Robinson, one of the directors, and Mr. Gaine, the general manager, and they will confirm me in stating that the National Company is willing to carry out those extensions needed in the district. It is desirable to have united action in meeting the varying circumstances of the day. For these reasons our board has been unanimous in coming to the conclusion that it is essential that the amalgamation should be carried out. Of course, the point as to the terms upon which the amalgamation should be carried out was a difficult one. It will be premature here to go fully into it, for it will be necessary to have a special meeting to consider the terms, and at the moment the provisional agreement is not signed. Matters have taken longer than we expected, but I hope it will be signed almost immediately, and then a special meeting will be called to consider the terms. I must refer to the lengthy negotiations that took place. As sellers, we naturally took a different view of the value of our ordinary shares from that taken by the National Company as buyers, and there was some difficulty in bringing our views into harmony, and our friends of the National Company will agree that we fought very hard to place the favourable features of our concern in the strongest light, and we were able, with the aid of our general manager, Mr. Lewis, and other gentlemen, to put the most favourable features of our company before the National directors, and although we did not get such terms as we hoped, and such terms as we think the value of the company entitled us to, we were able to modify the views of the National directors, and get a better proposed price than they at first contemplated. Under these circumstances, I think it is desirable that the proposed terms should be accepted, and although it may be a little irregular, I certainly think it desirable that I should mention what these terms are. A fair percentage will be given upon the market value of the shares, and when we consider that the ordinary shares have never earned two dividends besides the one which will be declared to-day, I think our friends will see that their position will not be injured at all by accepting the terms offered. The terms are: one £5 ordinary in the National, with a dividend declared upon April 30th last, to be given for 18 ordinary shares in our own company. The dividend on the National shares has been at the rate of 6 per cent., which is equal to 1⅛ per cent. on the par value of the ordinary shares, and to 6¾ per cent. on 5s., the average recent quotation for our shares. I must now move the adoption of the report and the statement of accounts.

Mr. MARK WHITWILL: I concur with all the chairman has said, and will content myself by simply seconding the resolution.

After a deal of discussion the resolution was adopted, and the proceedings terminated.

Notting Hill Electric Lighting Company, Limited.—The Notting Hill Electric Lighting Company, Limited, whose capital is £100,000 of which £70,020 has been subscribed and paid up in full, invite applications for the balance of £29,980 in the form of ordinary preference shares, bearing a preferential cumulative dividend at the rate of 6 per cent. per annum. In addition to this, the ordinary preference shares will be entitled, after the holders of the rest of the ordinary shares shall have been paid a dividend for the year at the rate of 6 per cent. per annum, to share *pari passu* with the ordinary shares in any dividend or bonus in excess of such 6 per cent. available for division. The object of this issue is to enable the company to extend the system to other parts of its area, the first extension being into the Phillimore estate.

The Mining and General Electric Lamp Company, Limited.—At an extraordinary general meeting of the members of the above named company, held on the 24th day May, 1892, the following extraordinary resolution was duly passed:—"That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily; and that James Howard Hays, of 11, Abchurch Lane, London, E.C., be and he is hereby appointed liquidator for the purposes of such winding up."

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of May were £3,600 as compared with £3,633 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of May, 1892, were £2,132, against £2,163 in the corresponding period of last year.

The Great Northern Telegraph Company. Receipts in May 1892, were, £22,000 1st January—31st May, 1892, £104,800; corresponding months, 1891, £114,000; corresponding months 1890, £105,800.

The Western and Brasilian Telegraph Company, Limited. The receipts for the week ending June 3rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company Limited, amounted to £3,082.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, June 2nd.	Closing Quotation, June 9th.	Business done during week ending June 9th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	101½	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	48½	...
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88½— 89½	88 — 89	89½	88½
2,849,510£	Do. do. Deferred	Stock	11 — 11½	10⅞— 11⅛	11⅛	11
130,000	Brazilian Submarine Telegraph, Limited	10	10¼— 10⅜	10¼— 10⅜	10 1/16	10⅛
53,200£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	105 —109	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞— 3⅛	2⅞— 3⅛	3⅛	2 13/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2¼	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½— 4½	3½— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2⅝— 3⅛	2⅝— 3⅛	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	9¾— 10¼	9¾— 10¼	10⅛	9⅞
$7,716,000	Commercial Cable, Capital Stock	$100	158 —163	158 —163	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛— ⅜	⅛— ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5⅛— 5⅜	5⅛— 5⅜	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3⅝	3½— 3⅝	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11½— 11⅝	11 1/16	11⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 15	14⅝— 15	15	14⅞
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜	15¼— 15⅜	15¼	...
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	109	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	109½	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15½	15 — 15¼	15½	14 13/16
78,300£	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	103 —106	103 —106	104	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	109⅜	109
135,000£	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 —105	102 —105	...	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	102⅜	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 6	5½— 6	5 1/16	5⅛
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1¼— 1½	1⅜	1¼
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2¼— 2½	2 7/16	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1¼— 1⅜	1⅜— 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10¼— 10½	10¼— 10½	10½	10 5/16
180,042	Do. do. 6 p. c. Preference	10	15½— 15⅝	15½— 15⅝	15⅝	15½
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	...	...
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 466/ to 14,000 ...	10	7⅞— 8¼	7⅞— 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½— 20½	19½— 20½	20⅛	19⅓
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —105	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ..	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 1/16— 3 3/16	3 1/16— 3 3/16	3⅛	3⅛
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7½— 7⅝	7½— 7⅝	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅞	4⅜— 4⅞	4⅞	4 11/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¼— 13⅜	13¼— 13⅜	13⅜	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	...	...
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	108 —110	108 —110	109	108⅜
250,000£	Do. (issued at 5 p.m., all paid)	...	104 —106	104 —106	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	7½	7
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½— 9	8½— 9	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8 3/16	8 1/16
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¼— 3⅜	3¼— 4	3 13/16	3⅜
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45½	44¼
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1½— 2½	1½— 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	3⅜	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	103 —107	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9¼— 9⅜xd	9¼— 9⅜xd	9 7/16	9⅜
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½xd	6 — 6½xd	6⅜	...
30,364	Do. do. do. 5 p. c. Deferred	7½	3½— 3⅝xd	3½— 3⅝xd	3½	...
189,700£	Do. do. do. 6 p. c. Debentures "A." 1910 ...	100	105 —108	105 —108	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	106⅛	...
88,321	West India and Panama Telegraph, Limited	10	1⅜— 1⅝xd	1¼— 1½xd	1⅜	1 5/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10xd	9⅜— 10½xd	10	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9xd	8 — 9 xd	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106	102 —106	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —119	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 7	6½— 7	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2—2½.—Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders shares, 6⅞—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5⅛.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

THE TELEPHONE AT HOME AND IN THE FIELD.*

BY MAJOR C. F. C. BERESFORD, R.E.

(*Concluded from page* 669.)

For Siege Operations.

Colonel Lyons, the commandant at Lydd, has made a series of valuable experiments with various forms of telephones for use in directing artillery fire at siege operations, and for observing and plotting results.

He has come to the conclusion that the telephone as a talking instrument is not reliable for this purpose, but that when in combination with the vibrating sounder it does excellent work. This, however, necessitates the employment of trained sounder clerks.

For Main Lines of Communication.

For work on main lines of communication the telephone, as a talking instrument, would not be of much service. In the first place, it would not carry the traffic which we are accustomed to, and, to give it fair play, it should be served by a well-insulated line, with double wires if on the same poles as other lines. These conditions are frequently impossible on long field lines.

At the same time, occasions would often arise when it might be desirable for commanders in the field to hold direct communication by telephone, and arrangements for accomplishing this at will should always be made.

The Belgian system, introduced by Major Waffelaert, admits of a telephone and telegraph instrument being used simultaneously on the same circuit, without interfering with each other.

We have in the British army an appliance known as a "separator," which accomplishes the same purpose, but it has not, as yet, come into general use, although it has a promising future before it.

As an example of what the telephone may be expected to do on a long field line, I may mention the experiments carried out during the summer exercise of the 1st division Telegraph Battalion last year.

A field line 70 miles in length was run between Aldershot and Chatham, and on many occasions was used for telephone work. The line, running as it did through woods, and narrow lanes where contacts with trees and hedge-rows were unavoidable, was a very leaky one, but did not prevent the telephonic communication being carried on with fair success.

The instruments used were the "Ader" and the "Operators" telephone, and on the occasion of a ball which took place at Chatham animated conversation was kept up between the guests and some officers at Aldershot. The "Ader" appeared to give the best results.

Intercommunication in Camps.

We are all familiar with the orderly, and also with the fact that the orderly's duty is one of those that thin the ranks, so that any means which can be adopted for lightening his work cannot fail to be grateful to commanding officers.

The advantages of the telegraph or telephone over messenger, horse or foot, are so great and so well recognised, as to render it unnecessary to repeat them here.

Outpost Telegraphs.

Under the head of outpost telegraphs there may be also included all light telegraph work in advance of an army. Whether in repair and utilisation of the lines of the country, temporary lines for local purposes, lines in connection with reconnaissances, or arrangements for tapping the enemy's wires.

We know that during the American Civil War the telegraph went ahead of all troops, with or without escort, generally the latter. We also know that during the Franco-German War of 1870-71, the telegraph work was frequently pushed ahead beyond the cavalry screen, and specially escorted for the purpose; such is the necessity in warfare of at once gaining communication to the front. We also see Continental powers equipping their cavalry with the telephone and telegraph, but it is to the former that the greatest attention is being given. It might now appear to us time to enquire whether we should not be moving in the same direction.

The instruments at present at our disposal have been briefly described, and endeavours made to give an idea of the extent of their powers, so as to open up a field for discussion as to how far a telephone, whether in its simplest form, or in combination with microphones, or telegraph instruments, might be made use of for outpost work.

We are not now uncertain of our field lines, as we were in years gone by, when our equipment was of inferior material. There is now a cable in our Service, weighing 77 lbs. per mile, that will stand a strain of 500 lbs., that I have frequently seen passed over by artillery and remain intact. In the vibrating sounder we possess an instrument which in combination with a telephone will transmit signals through bare wire laid on the ground, and even in water.

It rests then with those in command to say whether such means of communication as have been described would be useful on outpost duties.

Whether occasions would not arise when to be able to speak between main body, reserve, and picquets might not be of infinite value.

Whether the establishment of some detached post might not entirely depend on the facility of communicating with it.

Whether the fact of being able to communicate immediately with the chief points of an outpost line would not reduce the number of men necessary for outpost duty.

Whether the knowledge that communication was open throughout would not give confidence to the soldier.

And finally whether the mere fact of lines of cable, radiating from certain centres, would not be of great use, especially at night, as providing guides for reinforcements and the like.

Then as regards the cavalry: should they not be in a position to tap an enemy's line (which can be done with the telephone), or to complete and work a deserted circuit, when the local instruments would probably have been taken away. Or to run short lines for connecting their headquarters with certain points, or with the head of the advancing main line of communication.

These are mere suggestions; other occasions for use of the telephone will probably occur to many of you.

It is as a Morse receiver that I look for the best results from the telephone in this direction. But this would require trained clerks.

Any intelligent man, with a good ear, can in a few months be taught to read sufficiently well for most practical purposes connected with military local work. Many become fair operators in six months.

Most regimental signallers who pass through the Signalling School at Aldershot acquire there a fair knowledge of reading by sound, and it would be to those to whom the charge of regimental telephones would naturally fall.

But there are three chief reasons militating against the introduction of a regimental system of outpost telegraphy in the British Army:—

(1.) Expense.
(2.) Taking the soldier from the ranks for the purpose, and
(3.) If Morse signals are used, the difficulty of training men.

As regards the 1st, all that can be done is to simplify and cheapen the apparatus; and this is being accomplished year by year.

The 2nd reason might be met by the argument that adopting telephonic or telegraphic communication saves a number of men otherwise necessary for many duties.

The 3rd reason does not apply when the telphone is used only for talking, but, as it has been stated Morse signalling is perhaps the most effective for outpost work, this point must be considered, and it is the most difficult to meet.

It is to be hoped that the cost of the telephone will be so reduced year by year, that before long a signalling instrument may be within everyone's reach, and become of common use in a barrack. One requiring no microphone, battery, or vibrator, but read by Morse. It would then be found that the art of reading the signals would spread of itself.

One good Morse clerk in a regiment could instruct many others during the year, without taking a man from other duties. Small prizes, as for musketry, would give the impulse.

It is from the hands of the signallers that we should expect the best results, and a regimental telephone equipment would double their power, giving them an alternative when signalling was out of the question.

The Telephone in Foreign Armies.

France.—The question of outpost telegraphs has been well to the front, for some years, in Continental armies.

France has taken the lead from the time that she saw what the telegraph effected in the war of 1866, and ever since that period she has striven to get the most out of the products of science.

Not only were telegraph sections created for the work on the lines of communications, but outpost telegraphs were from time to time experimented with, and organised in different branches of the service.

In each cavalry regiment there are six telegraphers, *i.e.*, two groups of three men each; and a light one-horse cart carrying four drums of cable in ½ kilometre lengths, with the other equipment necessary. Each cavalry division has a two-horse waggon carrying 30 kilometres of cable, batteries and tools.

The telegraphers carry small batteries in their holsters, and telephones in their pouches.

What is known as "Trouvé's system," was introduced some years ago for dismounted outpost work, and consisted in a drum of double cable, 1,000 kilometres in length, carried on a man's back. The instruments originally used were small watch-shaped sounders, and *a*, *b*, *c* instruments. These were soon superseded by Siemens telephone, which about four years ago was itself superseded by the "Aubry" telephone. Trouvé's system was first used during the siege of Paris.

Various methods of call have been tried with the telephone, mostly modifications of the reed, but the cavalry are now supplied with vibrators. There is still, however, a want of a more perfect means of ensuring attention being gained, and amongst other devices may be mentioned a form of head-dress, by which telephones are strapped against the ears and a microphone before the mouth. A pattern of this description invented by Colonel Roulles, has, it is understood, been introduced into the artillery service.

Captain Zigang, a signalling officer, has lately invented a call of the reed form which is said to give good results.

In 1879 and 1880 a great number of battalions of the 6th Army Corps were supplied with Siemens telephones and 1,200 metres of cable each, but the experiments were not considered successful, and the advance of signalling at the time threw the subject temporarily into the shade.

The telegraph sections use Siemens telephones, fitted with keys in the handle, for transmitting and receiving Morse signals, such signals being much more easily transmitted than the voice.

Berthon's pattern of telephone with magneto call has lately been introduced into the French service.

In his article on the French armies, which appeared in the *Fortnightly Review* of November last, Sir Charles Dilke says, "The telephone was not, I heard, successful; the telegraph was very largely used."

This, it is to be supposed, entirely referred to the telephone as a "talking" instrument for outpost work, or on the lines of communication, and not for exchanges in camp, where there is no record of its having been used.

The following is an extract from an article by the special correspondent of the *Times*, on the late French manœuvres :—

"In addition to the balloon, the field telegraph and telephone were there to assist the leaders; 50 kilometres of cable are carried with the first line of troops. Each cavalry regiment can lay 2,200 yards of telephone line, and, with the cavalry brigade and division, 12,000 yards of telegraph.

"In the actions in Champagne, even the troops in the fighting line were linked with headquarters, and the independent cavalry divisions established a line as they advanced.

"The work was very rapidly executed, the trees which line the chaussées greatly facilitating the operation, and allowing the line to be raised as quickly as the troops could march."

Germany.—Germany has had for some years the Buchholz-Siemens system for outpost telegraphs. The detachment to work it consists of one non-commissioned officer and two men. They are provided with a knapsack, carrying 500 metres of double cable, and two Siemens recorders. The rate for paying out is 1 mile in 16½ minutes. In 1879 Germany had material for 60 double stations of outpost telegraphs.

A combined telephone and microphone similar to that introduced into our service has lately been adopted.

In sending a message by telephone in Germany, the words are sent in groups of three or four at a time, and repeated by the receiving clerk; any difficult word, such as "Leszczynski," is spelt out in numerals, which are more easily transmitted by telephone than letters, a table of numerals to correspond with the letters of the alphabet being constructed.

There is a strong prejudice in Germany against the use of the telephone, on account of its not recording the messages.

Belgium.—In Belgium Major Waffelaert, the officer commanding the Telegraph Corps, is a strong advocate of telegraphs for outpost work, and has devoted much time and thought to this subject. The system he has adopted for the Army telegraphs is that known as "Rysselberghe's," whereby it is possible to use, at will, the telephone and telegraph instrument, simultaneously or otherwise, on the same circuit. One of his chief reasons for this system is that it is employed on the State telegraphs in Belgium, and Major Waffelaert considers the advantage of the military telegraphs being able to work in connection with those of the country.

In addition to the Telegraph Corps, there is in Belgium a system of regimental telegraphs that has an equipment of the lightest possible description.

The cable has a core of four phosphor bronze wires, and only weighs 13 lbs. per mile.

Its breaking strain is about 80 lbs. One man carries 1,200 metres of this cable on three drums, arranged in a frame of exactly the same dimensions as his ordinary knapsack, the load being about 24 lbs.

The instruments, comprising telephone, microphone, battery, induction coil, and call, are carried in the cartridge cases of the infantry, and in the holsters of the cavalry.

Vibrators and reeds are used as "calls," and the telephone can be held against the ear by elastic bands.

By adding a small condenser the apparatus can be fitted up, as in the "Rysselberghe" system, the vibrator being used for Morse signals.

Major Waffelaert considers that Morse signals are not adapted for outpost work, on account of the difficulty of obtaining trained clerks, a matter discussed in another place in this paper.

Italy.—Italy has been disposed to use telephones for military work more than any other country. She was the first to make use of the vibrating armature for giving signals, and also makes use of the Morse key, in combination with the telephone.

Spain.—In Spain, owing to the mountainous character of the country, the whole telegraph equipment is of the lightest description, and carried on pack animals. Since 1859, the organisation for using telegraphs for tactical purposes has been contemplated.

Mounted outpost telegraph detachments were formed in 1868, but, on account of the number of mounted men required to carry the equipment, these were discontinued.

For outpost work, the original instrument was the "Trouvé" sounder, but this has since been replaced by the telephone and Morse key combined, as in Italy.

In Spain the outpost telegraph is pushed right up to the outpost line of picquets, and, it is said, with good result.

Russia.—Some eight or nine years ago an outpost instrument ("Horschelmann's") was introduced into the Russian cavalry; it was similar to the "Buchholz" of Germany, and carried on the saddle.

This was tried by the Uhlan Regiment of the Guard, and, from the results obtained, introduced into all the cavalry regiments. Whether it has been superseded by the telephone I am unable to say.

Austria.—Cavalry telegraphs were organised last year, for the purpose of connecting cavalry divisions with the nearest telegraph stations, and enabling them to make immediate use of the telegraph lines of the country. The telephone, no doubt will be largely used for the purpose.

Conclusion.

A statement of what might be expected from the telephone in its present development, having been laid before you, and suggestions made as to its employment, it only remains to touch on certain drawbacks attending the use, or rather the improper use, of both telephone and telegraph; classing the two together under one head.

In a recent article published in the Proceedings of this Institution it was stated that "the employment of this technical auxiliary in the first line restricts the high mobility of present warfare." It is possible, and even probable, that the telephone will often create unnecessary correspondence.

The ease with which communications can be held will offer temptation to the more feeble to seek the shelter of non-responsibility, to the wavering, increased facilities for vacillation, and to some others improved openings for making their presence (in the spirit) felt when least desirable. All this, I have no doubt, the writer had in his mind —in fact he saw centralisation encouraged by the telephone.

But there is another side to the picture. In a very remarkable article published by this Institution, in 1887, and entited the "March and the Battle," the following gives the key-note :—

"The little influence thus possessed by the Commander-in-Chief, in choosing the occasion for decisive action, is really an element of great difficulty in the warfare of the present day."

The whole of the article appears to me a most forcible argument, unintentionally, but unmistakably, showing the necessity for a wide extension of the telegraph. The urgent demand for that unity of action almost, if not altogether, lost under the conditions of modern war; "a great united effort instead of a number of isolated blows."

I would ask whether the telegraph restricted the mobility in the American Civil War; or, again, whether it did so in the Franco-German War. The history of the telegraph (and it is written for both) is a series of brilliant records of its achievements. "Technical art is striving hard to discover fresh means for enlarging the influence of those in supreme command," and the telephone is its latest effort.

PARLIAMENTARY NOTES.

MR. W. H. PREECE.

In the House of Commons on Friday, May 20th,

Mr. LABOUCHERE asked the Postmaster-General whether he was aware that Mr. W. H. Preece, the chief electrical engineer at the Post Office, was in the habit of taking private practice in electrical work; and whether, in view of the fact that he was a civil servant in receipt of an annual salary, that was in accordance with the rules of the Civil Service.

Mr. HENNIKER HEATON: Before the question of my genial but misinformed hon. friend is answered, I beg to ask the Postmaster-General whether he is aware that Mr. Preece has a high European reputation as an electrical specialist; that he could command double the salary he now receives from the Government if he would devote himself exclusively to private practice; that in the work he now does in his spare moments for the furtherance of electrical science he is rendering substantial service to the community.

Sir J. FERGUSSON: The case of Mr. Preece is exceptional. Before he entered Her Majesty's service 22 years ago he held certain paid employments besides his appointment as engineer of the Electric Telegraph Company. Those employments he relinquished as being incompatible with his appointment at the Post Office; but, with the knowledge of the department, he has continued to advise on great electrical questions outside of his regular duty, he being an expert of the highest standing. Such advice has been generally afforded to public bodies, for instance, in the lighting of the House of Commons, of the British Museum, the Dublin Museum, and the principal cities. His action in this respect has been quite public, and his reports have been published. As an electrician of European eminence he takes part in the development of electrical science. I am informed that he never turns to any work, other than departmental, during office hours, without special permission. But his official work is by no means confined to those hours. It is performed unsparingly early and late, and even on Sundays. As I have said his case is altogether exceptional and cannot form a precedent.

Mr. LABOUCHERE inquired whether Mr. Preece received separate fees for the assistance he rendered in connection with the electric lighting of the House of Commons.

Sir J. FERGUSSON thought it was highly probable that he did, and that he had also received separate fees for the assistance he had given to various public bodies.

TELEPHONES.

In the House of Commons on Thursday, May 26th,

Sir J. FERGUSSON moved for leave to introduce a Bill to make further provision respecting telegraphs.

Mr. JOHN ELLIS asked for some information as to the meaning of the Bill.

Sir J. FERGUSSON said that the short title of the Bill was a little misleading. The measure really referred to telephones, which, by a recent decision, had been included under telegraphs. The Bill was intended to carry out, as far as any legislative provision was required for that purpose, the scheme which he had explained to the House a month or two ago. But, as only a small part of the scheme required such legislative provision, a Treasury minute would be laid on the table setting out the whole scheme, and he hoped that this would be done before the second reading of the Bill was moved. It was the intention of the Government, after the second reading, to refer the Bill to a Select Committee. He hoped it would be read a second time before the Whitsuntide holidays.

Leave was then given to bring in the Bill, which was read a first time.

In the Vote of Supply the following matters concerning telegraphs were referred to :—

EXTENSION OF TELEGRAPH SERVICE.

On the House going into Supply last Friday week,

Sir J. FERGUSSON said: The extension of the telegraph service

would probably surprise the House. In ten years 2,722 new telegraph offices had been opened; before the last five years there were from 220 to 349 offices opened in a year; and this year the number of additional offices opened would be more than 400. The hon. member for Canterbury was opposed to the exaction of any guarantee, but without guarantees at all it would be difficult to draw a line, and to say how far extension should go and where it should stop. The terms on which extensions were made were now more liberal than they used to be. At one time the calculations included a sinking fund, but now nothing more was required than that the business should meet the costs of maintenance. If it was estimated that it would, then no guarantee was asked; and the fact that 600 offices were now open on that footing showed that considerable advantage was taken of the arrangement. Of course, advantage had been taken of the provisions of the Post Office Act, under which local authorities were empowered to guarantee the cost of a telegraph office. There was a Bill now before the House to extend that system to Scotland, the Isle of Man, and the Channel Islands, which, unfortunately, were not provided for before. He hoped the House would facilitate the passing of that Bill, which was greatly desired by the communities whom it would benefit. The abolition of the charge for porterage on the delivery of telegrams over certain distances would involve a considerable cost, and that cost would be felt all the more that the revenue from the telegraphs was not a growing one. He was afraid that for the present the charge of sixpence a mile must be borne by those who required telegrams to be taken to places remote from the office. He thoroughly appreciated the friendly spirit in which the subject had been introduced.

In making some remarks,

Mr. SHAW-LEFEVRE said that hon. members had reason, on the whole to be satisfied with the statement made by the Postmaster-General. He wished to remark that the telegraph service as a rule had been conducted on commercial principles, and that efforts had been made to balance the revenue and the expenditure. The telegraph service only just paid its way; at the present he believed there was a small deficit, and therefore he could not join the member for Canterbury in calling upon the Postmaster-General to extend the telegraph service to all parts of the country without a guarantee, nor to give a free delivery.

Sir W. FOSTER was pleased at the generous spirit of concession shown by the Postmaster-General, but he wished that the right-hon. gentleman had gone a little further and extended his generosity to the more neglected rural districts. For example, it ought not to be a question for a great public department like the Post Office to consider whether or not there would be a prompt return for outlay in the case of telegraphic extension guaranteed by localities. Such a return was bound to come when the facilities were granted, and he thought that the Post Office was too cautious in granting facilities for telegraph stations in various parts of the country. In some of the smaller towns of the country also he thought that it would be advisable if telegraphic facilities were a little further extended on Sundays, so as to admit of a reply being received to a telegram which had been sent. The telegraph stations in the smaller towns of 10,000 or 20,000 inhabitants ought not to be in the hands of persons engaged in local trade. The postmaster in such cases had the opportunity of reading the private telegrams of his competitors in trade, and such a position of affairs inflicted much injury on localities. He knew of one town where some of the inhabitants were in the habit of sending their messages to another station several miles away, and in some cases taking the train to neighbouring towns in order to secure privacy in their telegrams. After a little further discussion the matter dropped.

NEW PATENTS—1892.

3,113A. "Improved means for conveying currents of high tension and in appliances used for this purpose." S. Z. DE FERRANTI. Dated May 20th. [Date claimed under Patents Rule 19, 17th February, 1892.]

9,228. "Automatic electric mast-head and side light indicator." E. J. B. LOWDON. Dated May 16th.

9,253. "Improvements in apparatus for indicating electrically, words, numbers, places, or other terms." H. H. HALL. Dated May 16th.

9,282. "Improvements in multiple commutator apparatus for telephonic installations with metallic circuits of the system Berthon." C. D. ABEL. [Communicated by the Société Générale des Téléphones (Reseaux Telephoniques et Constructions Electriques), France.] Dated May 16th. *(Complete.)*

9,300. "Electrically heated matrix press." W. MITCHELL. Dated May 17th. *(Complete.)*

9,319. "Improvements in or connected with anodes for the electrolytic decomposition or formation of chemical compounds." A. HENNETON. Dated May 17th. *(Complete.)*

9,331. "Improvements in the mode of and apparatus for the transmission of currents through conduits for the propulsion electrically of railway cars, &c." J. W. GRANTLAND. Dated May 17th. *(Complete.)*

9,343. "Improvements in electric connectors for current converters." G. D. BURTON. Dated May 17th. *(Complete.)*

9,346. "Apparatus for the production by electrolysis of chlorine and alkalies." C. KELLNER. Dated May 17th.

9,347. "Process for the separation of the alkali obtained by electrolytical decomposition of halogen compounds from the electrolyte which has not been decomposed." C. KELLNER. Dated May 17th.

9,356. "Improvements in apparatus for distributing electric currents for heating purposes." G. D. BURTON. Dated May 17th. *(Complete.)*

9,362. "Improvements in and relating to electric metal-working apparatus." G. D. BURTON. Dated May 17th. *(Complete.)*

9,365. "Improvements in and relating to electric motors." R. LUNDELL and E. H. JOHNSON. Dated May 17th. *(Complete.)*

9,379. "Improvements relating to the heating and working of metal bars by electricity." G. D. BURTON. Dated May 17th. *(Complete.)*

9,380. "Improvements in mechanism for converting electric currents, and in the method of applying the same to the working of metals." G. D. BURTON. Dated May 17th. *(Complete.)*

9,409. "Improvements in electro-magnets for organs and for other suitable purposes." J. J. BINNS. Dated May 18th. *(Complete.)*

9,425. "Improvements in electrical switches." A. W. STEWART. Dated May 18th.

9,435. "Electric gong." H. NEHMER. Dated May 18th.

9,450. "Improvements applicable to electric bells and other instruments." WOODHOUSE AND RAWSON UNITED, LIMITED. (Communicated by R. Varley, United States.) Dated May 18th.

9,470. "Improvements in electric pushes." H. H. LAKE. (Communicated by C. Jörns, Germany.) Dated May 18th. *(Complete.)*

9,486. "Improvements in switches and crossings for the trolley wires in the overhead system of electric traction." A. DICKINSON. Dated May 19th.

9,496. "Improvements in telephones." Sir C. S. FORBES, Bart. Dated May 19th.

9,500. "Improvements in electric switches." J. M. M. MUNRO and J. MCFARLANE. Dated May 19th.

9,519. "Improvements in or appertaining to decorating or illuminating by means of the electric light." B. RIBIERE. Dated May 19th.

9,536. "Improvements in systems of electric distribution." H. J ALLISON. (Communicated by C. O. Mailloux, United States.) Dated May 19th.

9,541. "An improved electric accumulator or secondary battery." F. SCHMALHAUS. Dated May 19th. *(Complete.)*

9,559. "A new or improved electrical sounding apparatus." A. J. THOMAS. Dated May 19th.

9,566. "Improvements in electric percussive tools." L. B. ATKINSON. Dated May 19th.

9,569. "Improvements in or connected with electric batteries." C. P. SHREWSBURY and J. L. DOBELL. Dated May 19th.

9,612. "Improvements in dynamo-electric machines." W. LOWRIE. Dated May 20th.

9,613. "Improvements in or relating to the method of maintaining or regulating the potential in electric current circuits." W. LOWRIE. Dated May 20th.

9,623. "Improvements in electric batteries." J. VERNHET. Dated May 20th.

9,631. "Improvements in the construction of ozonisers." E. ANDREOLI. Dated May 20th. *(Complete.)*

9,678. "Improvements in electricity distribution." W. B. EDGAR and J. M. M. MUNRO. Dated May 21st.

9,685. "The manufacture of a porous magnetic ferric oxide filtering medium." C. H. G. HARVEY. Dated May 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

8,579. "Improvements relating to electrical belts, chiefly designed for medical purposes." C. B. HARNESS. Dated May 19th. The inventor secures to or mounts in the belt in a suitable manner, and in a convenient position, a battery, preferably a dry battery, of suitable construction, and an induction coil, and he connects the said coil in circuit with the ordinary contact plates of the belt. 3 claims.

10,260. "Improvements in and connected with electric signalling and lighting in trains, said improvements being also applicable for telegraphic and telephonic communication." A. SHIELS and W. ELLIOT. Dated June 17th. Claims:—1. A coupling for electric wires consisting of two parts, each part having a long and a short projection which, when clamped together, fit into one another, substantially as described with reference to the drawings. 2. A coupling for electric wires, consisting of two parts having long and short projections which carry the wires, the terminals of the wires being kept in close contact by means of springs or their equivalent, substantially as set forth. 3. In electric signalling on trains a push-knob circuit closer having a glass or mica window, substantially as and for the purpose set forth. 4. In electric signalling, telephoning, or telegraphing on trains, the use of spring terminals or contacts, substantially as described and shown on the drawings.

10,347. "Improved electric battery." D. FITZPATRICK. Dated June 18th. The improved battery is constructed with an inner fluted or corrugated hollow cylinder of carbon, and an outer cylinder of zinc as ordinary. 3 claims.

12,070. "An improved method of reciprocating the anchor of an

electric apparatus." H. D. FITZPATRICK. (Communicated from abroad by R. F. Schöller and R. H. Jahr, both of Germany.) Dated July 16th. Consists in the combination of one or more magnets having an even number of poles, with one or more having an odd number, and by changing the direction of the currents so as to produce a change in the polarity of one, or one set, of the magnets. 1 claim.

12,540. "Dynamo-electric machines." H. CUENOD, E. SAUTTER, and G. HOCHREUTINER. Dated December 31st, 1890. (Under International Convention.) Relates to a mixed system, in which the iron is employed in a very small quantity, just that required for solidity of construction, and arranged in such a manner, that the presence of this iron does not create any appreciable magnetic resistance. The conductors, supported by the iron, may be composed of multiple wires, as fine as may be desired, so as to avoid Foucault currents. The sections of winding follow each other regularly, as in a Gramme ring, without the inconvenience which drum windings of the Siemens class present, namely, the presence of neighbouring conductors between which there exists all the tension difference available at the terminals of the machine. 2 claims.

12,541. "A system for the automatic regulation of the position of the brushes of dynamo-electric machines, magneto-electric machines, and electric motors." H. CUENOD, E. SAUTTER, and G. HOCHREUTINER. Dated December 31st, 1890. (Under International Convention.) Consists of the combination with one of the collecting brushes of the dynamo of two telltale brushes placed the one in front, the other in rear of the said brush, and combined with an arrangement of any sort such, that a difference of tension existing between the two telltale brushes may produce the necessary displacement of the collecting brushes to replace these last to their normal position. 1 claim.

13,269. "Improvements in holders for electrical glow lamps." E. A. GIMINGHAM. Dated August 5th. Claim:—Connecting the wires of an electrical glow lamp to the sockets of the spring plungers by passing them through holes in the insulating base and in the metal bases of the sockets and pinching them in the latter by screws, substantially as described.

13,753. "Improvements in telegraphic call boxes." A. M. CLARK. Dated August 14th. (A communication by J. G. Noyes, of America.) Relates to certain improvements in telegraphic call boxes whereby the inadvertent transmission of an erroneous signal may be prevented. 3 claims.

THE SENSATION FROM AN ELECTRIC SHOCK.

THE *Canadian Electrical News*, December, 1891, contains a description by Albert Moyse, of Montmorency cotton mill, of his sensations from receiving the full charge of a 1,100-volt arc circuit.

The statement is graphic, suggestive, and calculated to make a modern Ananias, or even an expert witness, mad with envy. Mr. Moyse says: "As soon as I touched the wire with my right hand I felt myself drawn up with remarkable rapidity. Blue flames shot from my eyes. It was intensely blue, yet brilliant. I felt a sensation such as I never experienced before. As far as I could realise the feeling was pleasurable. I felt that my time had come, and I lost consciousness. I I afterwards learned that this experience had not taken more than two seconds. Those who saw the accident say that as soon as my hand touched the wire I was dragged up like a flash, dashed bodily against the ceiling, four feet above the wire, and then thrown to the floor—where I laid for over an hour unconscious. [He had stood below the wire at the moment of touching it.] At the time I got the shock the power was running through the wire at the rate of 1,100 volts. . . . When I came to my senses I was lying at the bottom of a cart, and was being driven home. For over ten minutes I could not remember anything. The man who was driving was one of the mill hands, but I could not remember who he was. He said he spoke to me, as did others in the cart, and that I answered back in a most foolish way. They thought I had lost my reason. I was taken to my home in this strange condition, and for some time could not recognise my own wife and family. When I fully regained my senses, I began to suffer for the first time. All over my body came tingling, pricking sensations, which were very agonising. Sparks would at intervals shoot from my eyes. My body was so sore that I could not bear my clothing, while my hair actually seemed to be electrified and to be raised from my scalp. I looked into a mirror and did not know myself, for my face was swollen to twice its natural size, while the skin had swollen so much on my forehead that it hung like a bag over my eyelids, almost preventing me from seeing. I was suffering very keenly. One of the men had gone to get Mr. Strachan, of the electric light company, to see if he could do anything for me. As soon as he saw me he took off my boots and socks and brought me into the yard, where he walked me barefooted over the damp earth. It was such a comfort as soon as my feet touched the earth! I could feel the electric fluid running through my body to my feet, and then into the earth. The cure was a speedy one, and I soon felt relieved. I was sore for days after, though."

CORRESPONDENCE.

Multiphase Motors.

In your issue of the 27th inst., on page 661 and 662, I see some remarks about the large exciting current of multiphase motors having no separate excitation.

I can inform you that by careful design it is possible to reduce the so-called exciting current to a very small amount, thus, in a 1 H.P. motor of my design the difference between apparent and real watts, when fully loaded, was about 15 per cent.; in a 20 H.P. motor the apparent watts were only 10 per cent. greater than the effective ones, and in a 65-H.P. motor I have cut them down to as low an amount as 6 per cent. All these motors worked without commutator, sliding contacts or separate excitation.

C. E. L. Brown.

Baden, *May 31st*, 1892.

Notes on the Light of the Electric Arc.

I have noticed an error in the paper read April 28th, 1892, by Mr. Trotter, before the Institution of Electrical Engineers. It was reported in the REVIEW of May 6th and 13th.

He assumes that he finds the mean spherical candle-power by finding the radius of a sphere equivalent in volume to a solid generated by the revolution of a plane figure bounded by a curve whose radius vector represents at each point both the direction of the ray and the candle-power. The plane curve represents the variations in candle-power in a plane passing through the axis of the carbons, and the revolution takes place about this axis.

It will be easily seen, I think, that the radius of such a sphere is not the mean of the radii vectors of the solid of equivalent volume, but that it is the cube root of the mean of the cubes of these radii vectors. Divide the solid into pyramids having equal and small solid angles at their vertices (each vertex to be at the origin). The volume of one of these pyramids will be one-third of the cube of the radius vector multiplied by the solid angle, $\frac{1}{3}\rho^3\, d\, w$. Integrating for the whole solid we have $\frac{1}{3}\int \rho^3\, d\, w = \frac{4\,\pi\,.\,R^3}{3}$ where R is the radius of the sphere of equivalent volume, and at the same time the cube root of the mean of the cubes of the radii vectors of the solid.

The proper value of the spherical candle-power might be obtained by plotting in cartesian form the products of the candle-powers and the cosines of the angles as ordinates, and the angles themselves as abscissæ, find the average value of the ordinate, divide it by the average value of the cosine, $\frac{\pi}{4}$, the result is the mean spherical candle-power.

George W. Patterson, Jun.

University of Michigan,
May 25th, 1892.

An Unfortunate Figaro.

An amusing case of lamp breakage came under my notice a few days ago. A hairdresser who has put up a motor for hair brushing, complained that whenever he brushed a customer's hair his lamp went out and could not be lighted again. This strange statement I found to be only too true. The lamps hang close to the pulleys and rubber belts, and the frictional electricity generated by the belt drew the filament over till it touched the glass and broke.

C. O. Grimshaw.

June 6th, 1892.